THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

VOL. XXIX. JUNE, 1905. No. 3.

THE ENGINEERING EXPORTS OF GREAT BRITAIN, GERMANY AND THE UNITED STATES.

By W. Pollard Digby.

PART I. THE TREND OF SUPREMACY, AS DISCLOSED IN THE GENERAL SITUATION.

There are certain impressive signs, especially in the vast present output of the world's most important metals—gold and iron—that we are just on the threshold of a period of industrial expansion rivaling any epoch of like character the world has ever seen. Under such conditions and expectations the question of markets—of the sources of new demand and the possibilities of new disposition of surplus production—attain unusual interest. Mr. Digby's examination of the subject is valuable particularly in that it relates to the products of engineering industry only, and to the relative standing and manifest tendency of the three great manufacturing nations. And the graphic method of presenting the results makes them immediately clear to the eye and renders comparisons remarkably easy. A following paper will take up the relative advances shown in the most important trade zones.—THE EDITORS.

THE wording of the title of this study serves to indicate to a certain extent the order of immensity of this section of the trade of the three chief manufacturing countries of the world. They are the only countries in which, according to their latest census returns, over 1,000,000 persons find employment in the preparation of iron and steel and manufactures thereof, including shipbuilding. In 1901, in the United Kingdom, 301 persons in every 10,000 of population, or an aggregate 1,249,000 employees, were so occupied. In 1900, in the United States, 152 persons per 10,000, or an aggregate of 1,151,000, were so engaged according to the census of that year. For Germany no later figures are available than those of 1895, according to which 215 per 10,000 of the

population, or a total of 1,115,000, found employment in this connection. If with these figures the numbers engaged in the allied industry of mining are in each case included, the very great importance to the United Kingdom of her engineering industries becomes even more strongly marked. While, however, the output of the metalliferous mines has an important bearing on the export trade of the manufactured article, the output of coal is also of importance. Apart from that which is directly exported as fuel for bunker or other purposes, a vast amount is used in each country, a portion of which appears as an indirect export in the shape of manufactured articles. In order, however, to restrict our enquiry within a reasonable scope, fuel, mineral ores, cement, and certain other articles must be omitted. There yet remains a very formidable list which includes railway rolling stock, motor cars, electrical goods, locomotive, agricultural and other steam engines; agricultural, textile, mining, electrical, and other machinery; iron and steel in the shape of angles, bolts, rod, rails, chairs, wire, galvanized sheets, tin-plates, ingots, nails, screws, rivets, tyres, axles, wheels, and ships and their machinery.

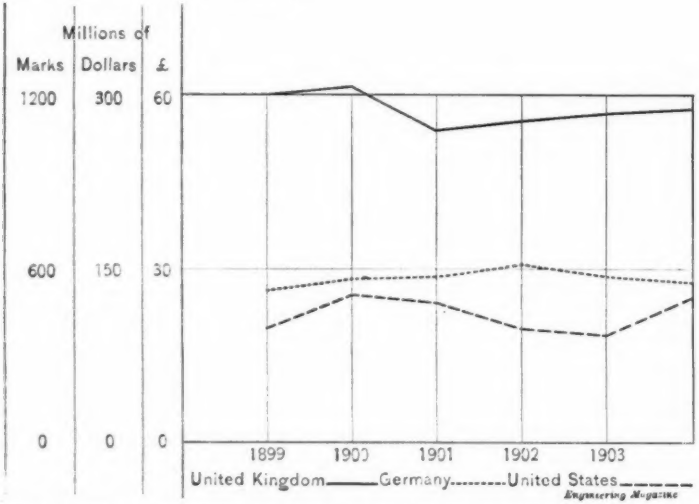


FIG. 1. TOTAL ENGINEERING EXPORTS OF THE UNITED KINGDOM, GERMANY, AND THE UNITED STATES.

Considering, in the first instance, the total engineering export trade of the three leading engineering countries of the world, we

have the following figures of the value in pounds sterling, 000's being omitted:—

Year.	1899.	1900.	1901.	1902.	1903.	1904.
	(All figures are in thousands of pounds sterling).					
United Kingdom	59,627	62,702	55,746	56,830	58,246	58,507
Germany	25,892	28,759	28,894	30,257	28,413	26,487
United States	18,743	24,383	23,464	19,711	19,827	25,711

In considering the above figures it must be remembered that the United Kingdom has the smallest population of the three countries.

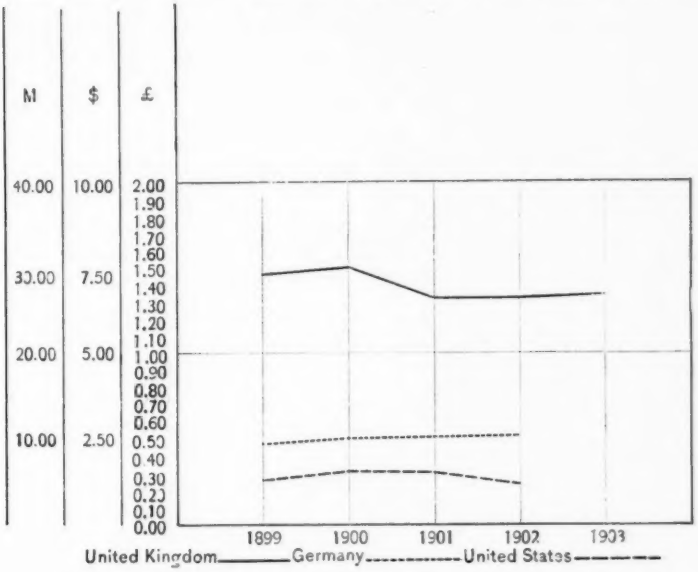


FIG. 2. VALUE OF ENGINEERING EXPORTS PER HEAD OF POPULATION.

If, therefore, we divide the above figures by the estimated population in each year, we obtain the approximate value of the engineering export trade per head of population.

Year.	£ 1899.	£ 1900.	£ 1901.	£ 1902.	£ 1903.
United Kingdom	1.46	1.52	1.34	1.34	1.37
Germany	0.47	0.51	0.51	0.52	....
United States	0.25	0.32	0.30	0.25	....

Taking for the moment 1902 only, to equal—relatively to population—the British position, the German exports would need to be increased by 250 per cent., and the American by over 530 per cent. There exists in England a somewhat large school of statistical students, who, ignoring the fluctuations which are inseparable from

the course of any trade, would point to the decline from £1.52 per head of population in 1900 to £1.34 in 1902 as against the German increase of £0.51 to £0.52, as irrefutable evidence of the imminent doom of Great Britain. Few of these would dare to foretell the collapse of American engineering industrialism, because the American figures showed a fall from £0.32 to £0.25. In this case they would be quick to recognise the importance of the unascertained internal commerce of the vast area comprised within the Union. If only figures were forthcoming in Great Britain of the huge internal trade which demands engineering manufactures in such great variety, the present fiscal movement would bear a very striking resemblance to a deflated motor-car tyre. It is this ignorance of internal trade, no less than the ignorance of the conditions as to past prices and the reasons of their then inflation, which causes the so frequent selection of the early seventies as the golden era of British commerce. The sole standard with too many enquirers is that of over-sea commerce. In some cases the standard is tempered by a reference to statistics of pauperism, in regard to which there has been a continuous change of standard as to what constitutes poverty. I do not proclaim that export statistics should be ignored. Rather should they be considered intelligently as representing the means by which a country pays for a portion of its imports of food, raw material, or luxuries. According to the internal demands for food and raw materials must a country's export trade be judged. Exports can never be so vital to the United States, which is practically independent of external supplies of food, cotton, or iron ore, as to the United Kingdom which grows but little food, no cotton, and depends on imported ore for about 40 per cent. of the pig iron which is produced. The States, therefore, can only exchange their produce against manufactures or tropical luxuries, or use an excess margin of exports to extinguish national indebtedness, or employ it as a means of investment in other countries. Germany, while more agricultural than Great Britain, equally lacks raw cotton, but is relatively less dependent on food supplies. She can therefore compete in the world's markets with Great Britain on a rather formidable scale for raw wool, raw cotton, and even for iron ore. On the other hand, with less wealth invested abroad, a greater proportion of German imports represent the result of barter than is the case for Britain, a portion of whose imports are the interest of foreign investments.

* It must be remembered that the United States fiscal year ends June 30, while the British and German fiscal years each end on December 31. All American figures quoted refer to the American fiscal year.

A disquisition, however, on the elements of political economy would be out of place; I must therefore leave this aspect of the question for a consideration of the relative positions occupied in the neutral markets of the world by the three arch manufacturing countries. Before commencing to review, a last comparison may be made between the United Kingdom and the United States by a computation of the value of the engineering exports per head of population employed in the parallel industries.

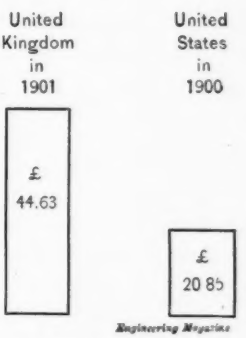


FIG. 3. VALUE OF ENGINEERING EXPORTS PER WORKER ENGAGED IN ENGINEERING INDUSTRIES.

As the latest German figures of population employed in engineering only apply to 1895, a year outside the scope of our immediate enquiry, there is no reason for their present inclusion.

United Kingdom (1901), £ value per head of engineering population.... 44.63
United States (1900), do. do. do. 20.85

PART II. INTERCHANGES OF ENGINEERING MANUFACTURES BETWEEN THE THREE COUNTRIES.

United Kingdom.—Inasmuch as a considerable amount of the export trade of these countries is done with one another, it becomes necessary to consider for each in turn the market which it offers to the other's goods. The following are the total figures for the United Kingdom collected from the detailed trade returns issued by the Board of Trade:—

Year. Imports, ex	1899.	1900.	1901.	1902.	1903.
	In thousands of pounds sterling.				
Germany	1,115	1,340	1,603	1,638	1,287
United States	4,093	3,781	3,614	3,809	3,130
Total	5,208	5,121	5,217	5,447	4,417

From Germany the exports have consisted chiefly of machinery and of several articles in a semi-finished condition, such as plates, bars, angles, etc. There is very little doubt that in the four years mentioned a considerable proportion of German iron and steel has entered Great Britain via Belgium or Holland. This question of competing routes, by which it may happen that the country from which goods are imported is not the country of actual origin, has received the consideration of the officials of the Board of Trade, with the result that among the information given in the second "Enquiry Blue Book" of 1904, is that of the relative value of the imports into the United Kingdom during the first six months of 1904.

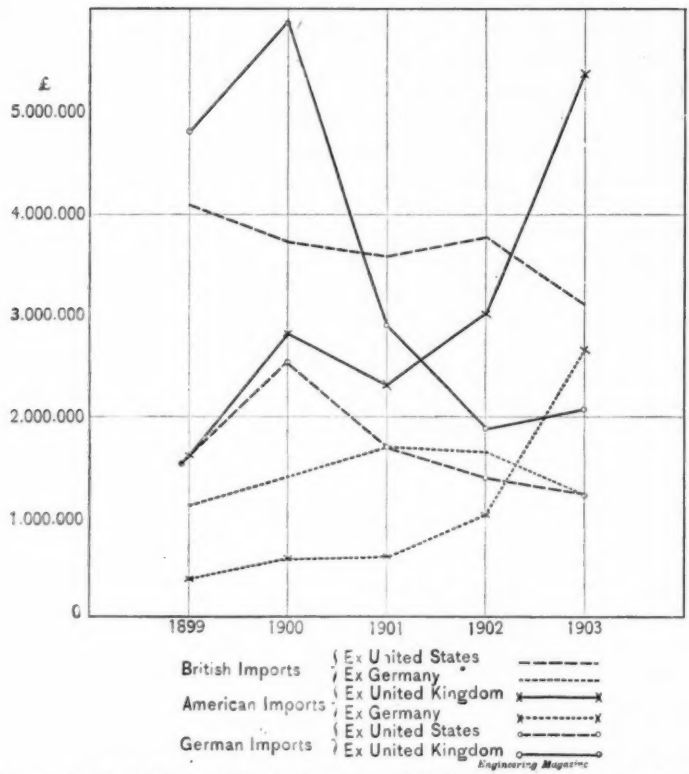


FIG. 4. TOTAL VALUE OF INTERCHANGE OF ENGINEERING COMMODITIES BETWEEN THE UNITED KINGDOM, GERMANY, AND THE UNITED STATES.

distinguishing the value received from, and the value consigned to, each country. Thus, of the imports from Germany which amounted to 23½ millions sterling, only 13⅓ millions' worth came direct from Germany, while goods worth 10 millions sterling came via Holland and Belgium. It is absolutely impossible to apply any correction on this account to the foregoing table, while the inclusion of the imports from Holland and Belgium would only serve to furnish an unsatisfactory and exaggerated estimate, as the latter country at any rate possesses large engineering industries of its own.

With regard to the imports of engineering manufactures into the British market, it must also be remembered that part are directly re-exported in the condition in which they arrived, by reason of the

exceptional position which Great Britain occupies as an entrepot of the world's produce, through its present fiscal position and splendid shipping supremacy. Part also of the imports, being in a semi-manufactured condition, are worked up into a more highly finished form and re-exported in that state. In all the figures given in the succeeding pages of British exports, direct re-exports are excluded, only those returned as of British or Irish manufacture being enumerated.

Germany.—Just as the United Kingdom affords a market for certain goods of engineering utility of German or American origin, so also Germany imports goods coming under this category from the two other countries. The following figures are taken from the German returns. They do not agree exactly with the export figures in the British returns. This is due to alterations and differences in classification:

Year.	1899.	1900.	1901.	1902.	1903.
Imports, ex	In thousands of pounds sterling.				
Great Britain and Ireland.....	4,713	5,812	2,835	1,879	2,169
United States	1,604	2,499	1,639	1,216	1,098
Total.....	6,317	8,311	4,474	3,095	3,267

Compared with the British figures given earlier in this section, the German figures show wide fluctuations. Whereas the difference between any two succeeding years of the period under review of the British engineering imports from Germany and the States does not greatly exceed 2 per cent., the German figures show that during the depression of 1901-1902, the variation between 1900 and 1901 was about 45 per cent., and nearly 30 per cent. between 1901 and 1902. Yet Britain has been called the dumping ground of the world, and woeful pictures are being continually paraded of the imminent downfall of British trade because of the manner in which the "protected" Yankee or Teuton undersells her manufacturers. Of the comparative hold of England and the States on the German market, it will be seen about two-thirds of the goods now come from the former country, while compared with 1900, the "boom" year, the greatest relative retrogression has been British. The above table is based on abstracts in parts 11 and 20 of the "Auswartiger Handel des Deutschen Zollgebiets im Jahre 1903," a publication to which repeated reference will be made in the succeeding pages. The import figures quoted are the sum of the "Spezialhandel" or "Special Trade," which includes goods imported for use or consumption at home, materials and components imported in order to be made up in the country and then exported, together with duty-free goods

which, having been imported, will be sold for export without change of form. These special goods are imported under the two main groups of (6) iron and iron wares, and of (15) instruments (i. e., tools), machinery, and ships. Of specific items from the United States, there has been a marked decline of metal-working machines, while typewriters have increased, sewing machines only slightly receding. The British retrogression has been mainly in regard to iron and steel wares, and (slightly) in regard to machinery.

United States.—With regard to oversea commerce proximity is often an important factor, yet distance does not so materially affect the inter-commercial relations between the United States on the one side and England and Germany on the other as might be supposed, as in addition to supplying England and Germany with certain articles, the United States make considerable purchases of tin plates, cutlery, and machinery from these countries. The following are the total figures:—

Year.	1899.	1900.	1901.	1902.	1903.
Imports, ex	In thousands of pounds sterling.				
United Kingdom	1,507	2,821	2,282	3,064	5,201
Germany	333	564	609	1,054	2,674

The dominant factor in the imports from Great Britain have been those of the "ruined" tin-plate industry; indeed, the rise in this connection between 1901 and 1902 accounted for more than half of the increase. Large imports of wire rods, pig iron, and ingots also came from Great Britain; general increases under these heads counterbalancing a loss between 1901-1902 of £100,000 in the value of British machinery. The year 1903 was marked by extensive pig-iron imports. In 1903 the imports of tin plates fell, but the imports of British machinery rose in value. The German increase throughout this period is due to a rise in exports of steel ingots, bars, blooms, etc., and in the cutlery and machinery trade. It may be mentioned in passing that in 1902 while $5,995,515 worth of tin plates came from the United Kingdom, $147 worth came from Germany. The general trends of American imports under certain specified headings are shewn in Diagram No. 5.

PART III. THE RELATIVE HOLD OF SPECIFIC ENGINEERING MARKETS.

Continental Europe (Excluding Germany).—At the outset, it must be conceded that questions both of geographic position and of community of language between buyer and seller are important factors in determining the export trade from any country to any particular country, or to the group of countries comprised in any trade

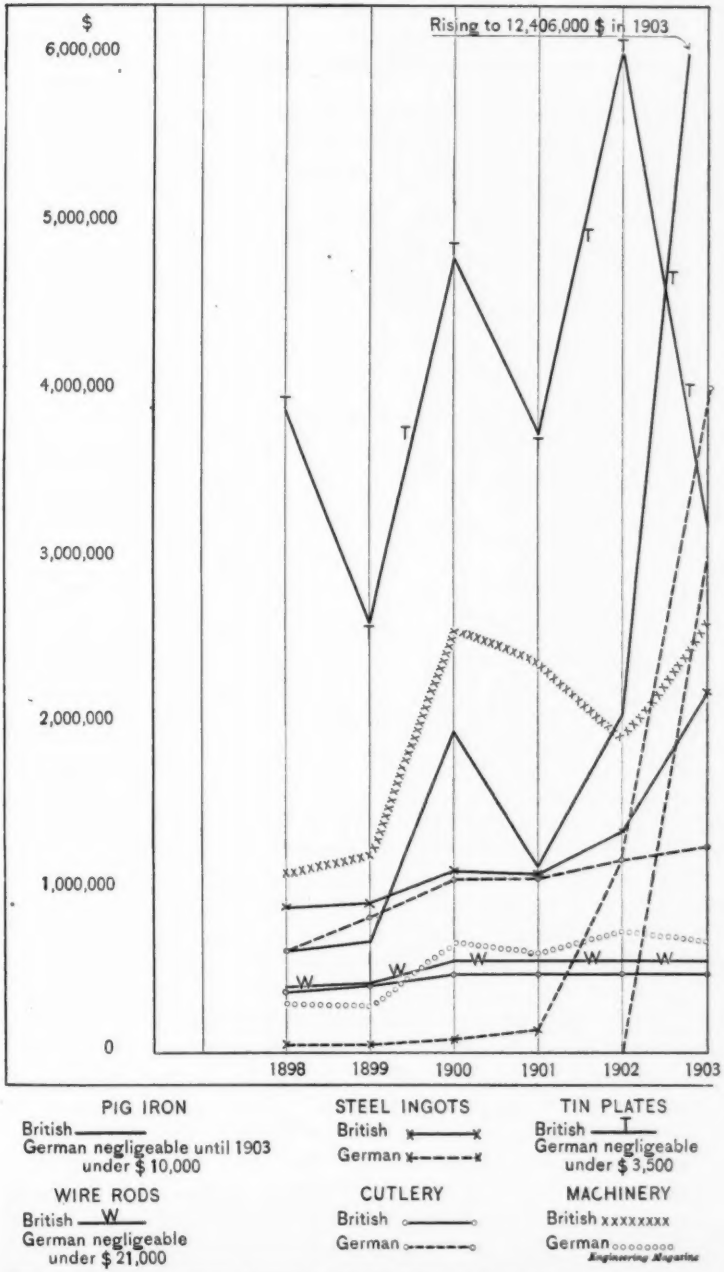


FIG. 5. COURSE OF CHIEF AMERICAN ENGINEERING IMPORTS FROM THE UNITED KINGDOM AND GERMANY.

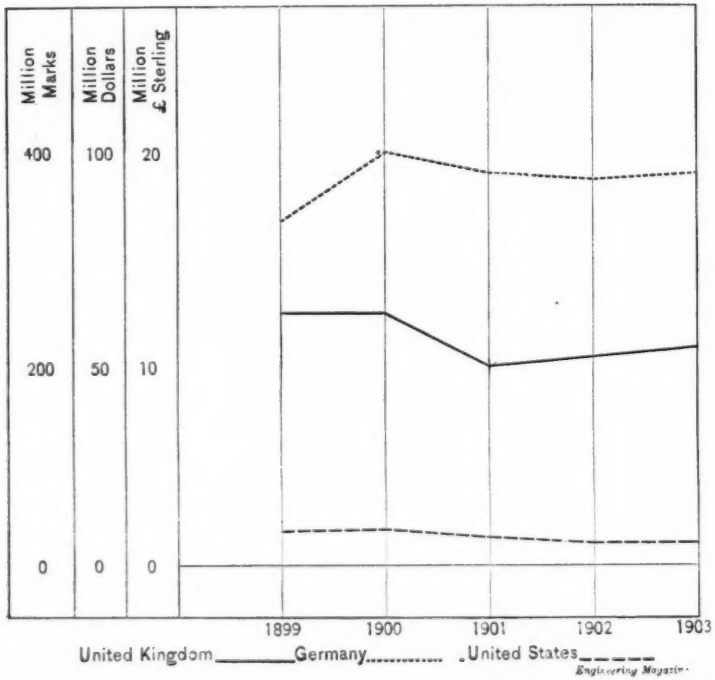


FIG. 6. TOTAL ENGINEERING EXPORTS OF THE UNITED KINGDOM, GERMANY, AND THE UNITED STATES TO EIGHT EUROPEAN COUNTRIES.

zone. Very much of the recent success of the German trader in the world's neutral markets is due to his recognition of this fact. Partly by his linguistic accomplishments, the German is securing in the English-speaking world a trade in many ways superior to that which the Briton is retaining in the non-English speaking world. Situated in the centre of Continental Europe, Germany is also at a great advantage geographically as compared with the steel manufacturer of Middlesbrough or Pittsburg. The element of time, both in obtaining tenders and securing delivery, is wholly to the advantage of Germany in any competition with the United States, but is not so greatly so in the case of competition with Great Britain.

To enumerate the trade of every small State is not essential to a sufficiently accurate survey of the general trends of trade in the European market. It suffices, therefore, to compute the total volume of the trade in each case between the three manufacturing countries,

and Belgium, Italy, Russia, France, Holland, Spain, Portugal, and Austria-Hungary, and to regard this as a fair index to the relative hold on the European market retained by these countries.

EXPORTS TO EIGHT EUROPEAN COUNTRIES.

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	14,016	14,167	9,666	10,330	10,691
Germany	16,307	19,680	18,633	18,432	18,866
United States	2,134	2,390	2,033	1,789	1,971

This particular group of countries is notable on account of the position held by the German Empire. In 1899, 50 per cent. of the

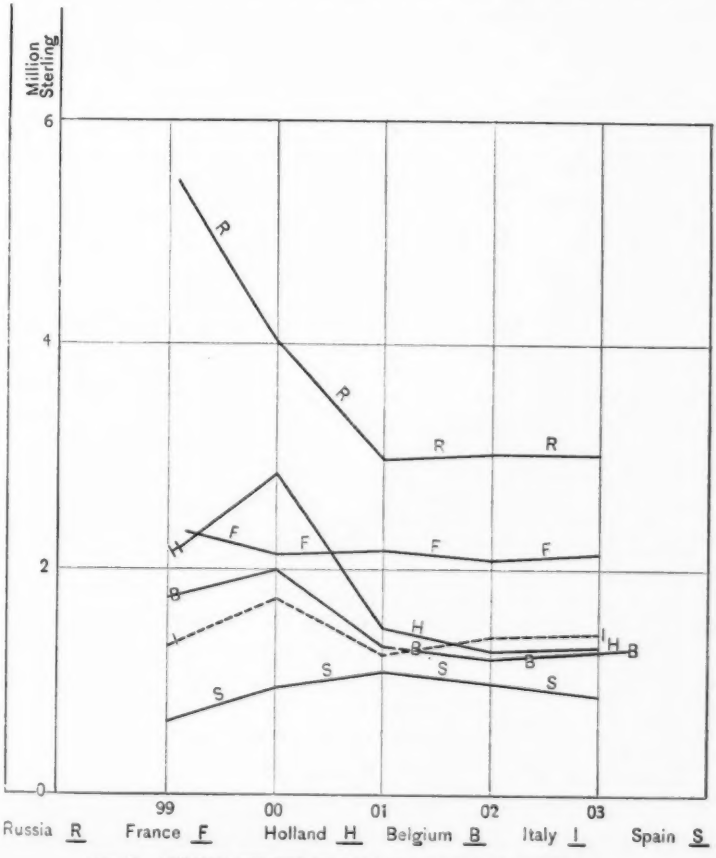
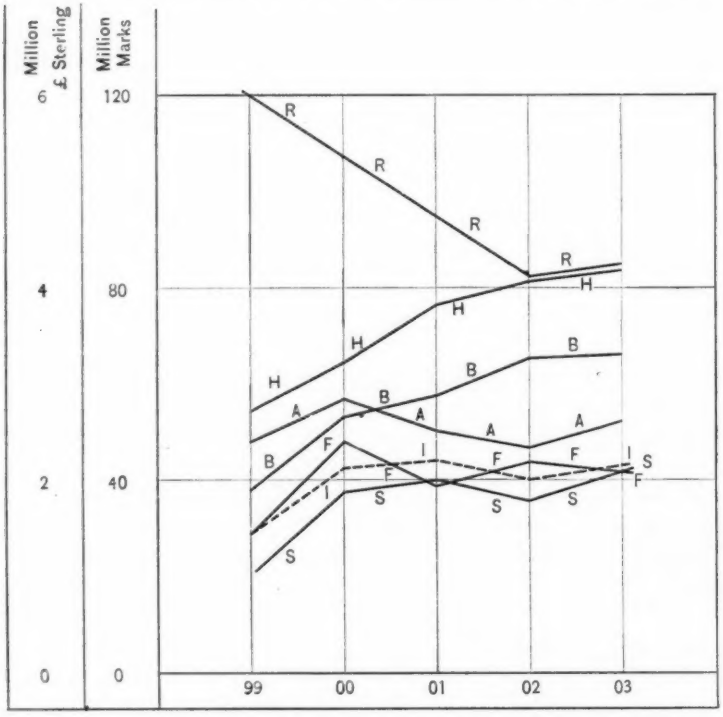


FIG. 7. BRITISH EXPORTS TO LEADING EUROPEAN COUNTRIES.

engineering trade was German; in 1902, owing to the large British (and small, American) declines, the percentage was nearer 64. The American hold on this market is a slight one, and reached its maximum in 1900—the year of phenomenal activity. This group of eight European countries enumerated above forms the chief German market, receiving in 1900 nearly 68 per cent. of the German engineering exports, 9 per cent. of the American, and barely 23 per cent. of the British exports. These figures are illustrated in Diagram No. 6. The British decline since 1899 and 1900 has not been confined to any particular country, although it has been most marked in the case of Russia, Belgium, and Holland. Of individual items, the tin-plate exports have increased in nearly each year to each country; this advance has been outweighed by the decline in the exports of ma-



Russia R Holland H Belgium B Austria-Hungary A France F Italy I

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FIG. 8. GERMAN ENGINEERING EXPORTS TO LEADING EUROPEAN COUNTRIES.

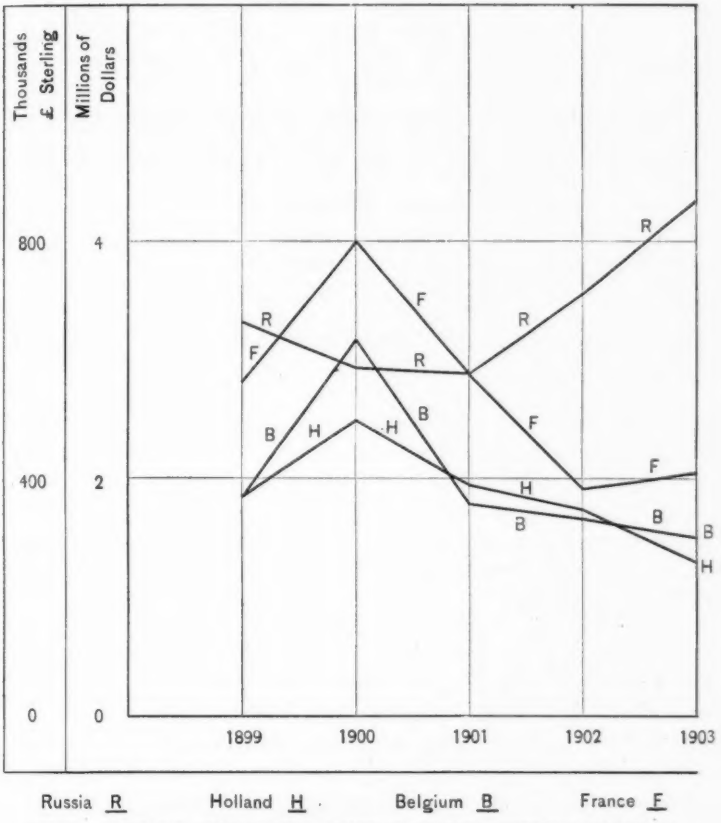


FIG. 9. AMERICAN ENGINEERING EXPORTS TO LEADING EUROPEAN COUNTRIES.

chinery and mill work, and in iron and steel wares generally. Diagram No. 7 gives the fluctuations of the total British exports to the chief countries. The German trade has been fairly uniform to each of the countries, save that there has been a marked decline in the trade to Russia, and save also the exports to Holland and Belgium.

As regards the American exports of engineering goods to Continental Europe, curves are given on Diagram No. 9 for only four countries. Save for Russia, there have been declines in the case of the exports to France, Holland and Belgium. The American trade to the other countries of this zone is relatively negligible.

To be continued.

ROLL TURNING: AN IMPORTANT MECHANICAL FEATURE IN THE IRON AND STEEL INDUSTRY.

By W. S. Standiford.

The department of engineering industry discussed by Mr. Standiford occupies an interesting field lying within the joint province of mechanical and metallurgical engineering. It exhibits a development in which the machine-tool builder—who owes so much to the iron and steel maker—has repaid an important part of his debt.—THE EDITORS.

AMONG all the various trades in the world, that of roll turning occupies a position which is important and unique. It is an occupation that is little known except by those who work in rolling mills, and the average person generally has a very hazy idea of the trade. I once asked a man: "What is a roll turner?" The answer received was: "A roll turner is a baker." This man evidently had bakers' rolls on the brain. Some other people think that a roll turner is a machinist; this also is a wide mistake, as the trades are separate and distinct, the lathe and tools used in the one working in an entirely different manner from that characteristic of the other. As a general rule, machinists know nothing about roll turning; of course there are some who have taken advantage of an opportunity and learned the trade, but there are very few of them, as the rank and file of journeymen are recruited from apprentices who have served their four years time at turning rolls.

The influence that this trade has on the progress and civilization of the world is most remarkable as well as beneficial. Before the era of rolling iron and steel beams, rails, etc., came into use, the usual method was to forge or cast them. This was a slow and uncertain way, and produced articles far inferior in strength and appearance to the rolled ones; the output also was limited. The reason why the cast is inferior to the rolled section is that rolling gives a fibrous and more homogenous structure which resists strains better. The rapidity with which various shapes and sections of steel can be rolled, as well as the excellent quality and cheapness per ton secured, has given to the world an engineering material that is unsurpassed for building bridges, steamships, and machinery, and the cheapness of its production is due largely to the improvements in roll turning and rolling. Much of the comfort and safety in traveling, and many of the

luxuries we enjoy nowadays, are due to the roll-turner's art, and it is the foundation of the iron, steel, copper and brass industries.

Roll turning was invented in 1784 by Henry Cort, and ever since then the trade has been developed by various roll turners and mechanical engineers, each one having added his mite, until we have in our modern reversing and continuous mills machinery that is capable of turning out an enormous tonnage of iron and steel with very few men employed to handle the mills; this produces large profits with small expenses, and also a first-class product. The majority of rolling mills in the United States, however, are small ones, capable of turning out an output of 15 tons per turn and upwards. They are gradually giving place to modern equipment, and there is no doubt but that in the future the small industrial plants will be equipped with up-to-date machinery. The rivalry for commercial supremacy will finally bring about this result. It is a case of survival of the fittest.

While the science of roll turning has advanced very rapidly, yet curiously enough, there have been very few improvements in the lathe by which the roll turner produces such excellent results. Such as have been made relate to minor details, such as adjustments to permit the topping of rolls quickly, the fastening of the tool rest, the tailstock, the shape of housings, and a few other devices. But the fundamental principle of working remains the same, and always will despite the march of progress in other directions.

The roll lathe is a machine of extreme simplicity, and the turning tools are of such a character, and the methods of working them are such, as are found in no other lathe. The machine is built in various sizes, to take in different classes of work. It consists of a long and wide bed, hollow in the middle to hold the turnings, technically called "swarth." The necessary gearing and pulleys to drive the machine are located at one end of the bed. In modern mills the lathe is directly connected by gearing to an electric motor, thus doing away with belting. Revolving on a hollow shaft connected with the gearing, and placed at a right angle to the bed, is a heavy wheel 4 feet or more in diameter, called the "face plate," which has bolted onto the side, in the middle, a square shaped box with fluted insides. Projecting outside the box is a square piece of iron about 18 inches long, with fluted sides; this is called a "spindle." Over this spindle is placed a round iron box about 8 inches long, and fluted inside; this is made of sufficient size to slide freely on the spindle. This arrangement is used to drive the roll when it is in the lathe.

All rolls are made with a journal or neck on each end, and also

fluted wobblers on the extreme ends of the roll. The wobblers are of such a size that the round box on the end of spindle is placed half way on the latter, and half way on the roll. This makes a very flexible driver. Placed across the bed of the lathe are two cast-iron devices called "housings." There are square depressions in the middle of each housing, each containing an iron block with the upper end hollowed out and lined with babbit. These form the bearings for the necks of the roll to revolve in. The bearings are so arranged as to have some end play, this being secured by set screws on the housing. The back ends of the latter usually have small blocks of iron to form the back bearings. The top bearings or caps are formed of long rectangular pieces of cast iron having a circular depression in the middle, and each having a round hole of sufficient size to go over the back ends of the housings, and down it. The front ends of the caps have inverted U-shaped slots. Through these extend long iron rods each threaded on the upper end and carrying a nut and washer. The lower ends of the rods are slotted and are held in place by keys.

The back ends of the housing where the caps go over it contain a rectangular slot, and also a removable key which, with the aid of the threaded front rod with its washer and nuts, keep the top bearings or caps pressing down on the roll. The latter is put into the lathe, and so adjusted that there is ¼-inch clearance between the driving spindle and the wobbler on the roll, the spindle being turned around until the flutes in it are opposite the flutes in the roll wobbler, and the box being pushed half-way onto the wobbler.

The caps are then placed on the necks of the roll, the keys put in the back ends and the nuts on the front rods tightened. The set screws that operate the bottom bearings are then screwed up to prevent end play of the roll; the back bearings also are pressed against the necks by the screws in the back of the housings. Across the front ends of the housings is placed a long rectangular casting containing two inverted T-shaped slots, one at the front end and the other at the back. It also has numerous square holes, extending from top to bottom. It is held from sliding endwise by lugs cast on the bottom, with set screws through it pressing against the housings. The front ends of the latter are also provided with set screws to hold it in place. In the slot next to the roll is placed the tool carriage, a rectangular forging with flanges on the bottom of sufficient size to allow it to slide freely in the slot. On the front slot is located the pusher, which is a solid piece of iron, with a flange on the bottom and having a long set screw. This is used to feed the tool into the roll.

There is considerable difference between roll-lathe tools and machinist tools, their shape and methods of working being entirely different. In order to show this clearly, we will suppose that a groove is to be turned in a roll for making bar iron. The tool consists of a piece of hardened steel 1¼ inches thick, 12 inches long, the width depending upon the size of groove wanted; in this case it will be 4 inches wide. The front end is ground to a straight edge; the right and left sides of the tool are ground a few degrees off a right angle, so as to leave the groove with a slight taper for clearance. The bottom and sides of the tool also are tapered so as to clear the roll, leaving the top edges to do the cutting. It is placed in the tool carriage, a small flat piece of iron called "packing" placed on it, and an iron wedge driven in to hold it in place. A post containing a set screw is then put in one of the square holes in the rest opposite the front of the tool, another post being placed on the other side near the rear end. The pusher is then placed in position back of the tool; the lathe is started up, the wrench on pusher is turned until the tool begins to cut, and given a turn every revolution of the roll to keep the tool cutting. Should the roll be calipered at this juncture, it will usually be found that the cut is not going down straight, one part of the roll being cut deeper than the other. This is remedied by giving the shank a light tap with the hammer or else pressing the shank over by tightening the set screws in the side posts.

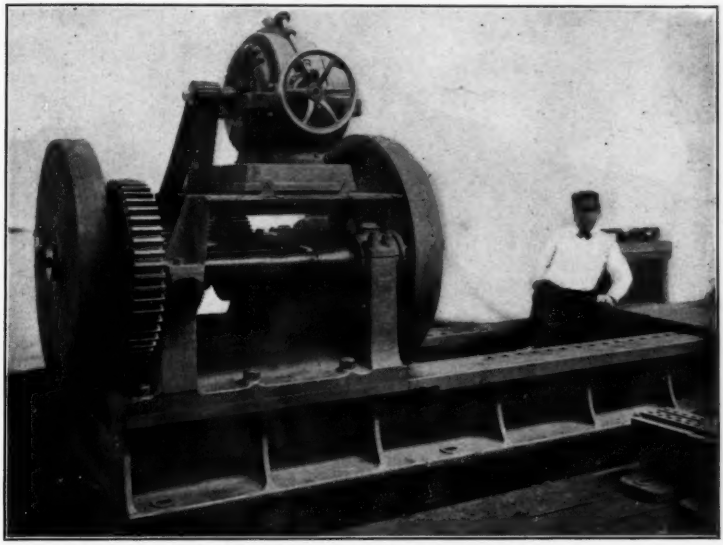
In managing the tool and handling the calipers there is considerable difference between the roll turner and machinist. The latter, in beginning new work, sets his calipers a little larger than the finished size that is wanted, and feeds the tool (attached to the slide rest) into the work by hand, calipering with the set-spring calipers until he has the desired size. Then he connects his slide rest with the lead screw and the tool is then dragged sideways along the work, cutting on the side and point. The V's on the lathe and carriage ensure that the work is turned straight. Work turned on a machinist lathe is always slightly out of true circular form, no matter how fine the feed is. This is due to the cut being dragged sideways before it runs out.

The machinist when sizing work with his calipers generally has a heavier touch than a roll turner. The latter handles his calipers so as just to feel the work; this is called a "feather" touch and is essential to good roll turning. In order to keep the cut going straight, the groove has to be calipered often. When it is within 1/32 inch of the finished size wanted, the workman takes out the roughing tool

and puts in the finishing one, which is very sharp; he takes a light cut and allows it to run out, when the groove will be found to be accurately round.

In turning the necks or journals for rolls, the housings, rest, and driving box and spindle are removed from the lathe. A center is put in the hole in the face-plate shaft, the tailstock containing the other center is put in place on the bed of the lathe, and bolted down. The roll is centered and bored with holes in the ends of the wobblers to match the angle of the lathe centers. A driving dog is slipped over the end of one wobbler, its bent ends pressing against lugs cast in relief on the face plate. This drives the roll when it is on the centers. The tool rest for necking is a casting about 2 feet wide, having the usual slots and holes on its top, as previously described. The rest is of sufficient length to go across the bed, the height being such as to allow the tool to be one inch below the center, which gives better cutting power to it. A machinist tool is usually set to cut on the center or above it. Roll-turners' tools will not cut above the center nor if placed on the exact center, but always have to be placed below. The power required for roll lathes varies with the width and angle of tool used, the weight of the roll and the material turned (as for example sand chilled and steel rolls) and also with the heaviness of cut. Using a 3½-inch wide tool and taking a heavy roughing cut on a steel roll, 7½ horse power is required to turn the lathe. Taking a finishing cut with the same sized tool, and on the same roll, 3½ horse power was needed. These results were taken from actual tests and are gotten by electrical measurements, the lathe being driven by an electric motor of 15 horse power. Heavier cuts can be taken on sand than on steel rolls. This is due partly to the tougher nature of steel, and also to the "drawing-in" action which it exerts on a tool when a steel roll is being turned. When a heavy cut is taken, the roll continues to draw the tool in, until the latter has over-reached its maximum cutting capacity; then the weight of the roll comes on the tool, bending the prop under it and breaking the tool. For this reason it is advisable not to take too heavy cuts in working steel.

It must be understood that the above mentioned width is not the widest tool that can be used on roll lathes, various sizes being used. The width of the tool used depends also on the power supplied, some belt-driven lathes having all they can do to pull a cut 6 inches wide. Steel for roll-turning tools should be very high in carbon, 1.50 per cent. making fine tools. This, however, must be heated carefully by the blacksmith, so as to avoid burning; a cherry red is the highest that

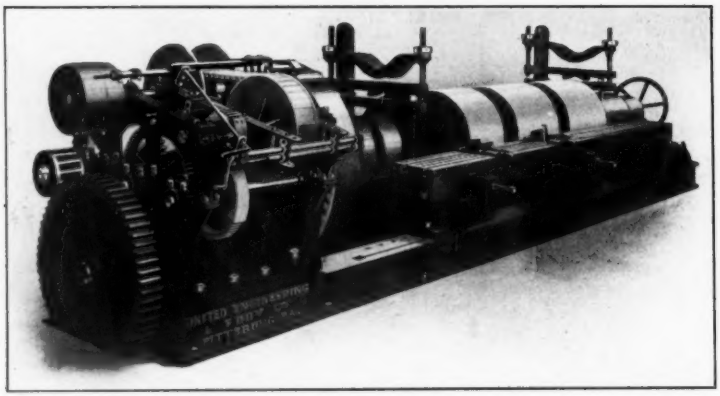


ROLL LATHE DRIVEN BY VARIABLE-SPEED MOTOR.

Made in sizes suitable for turning rolls 26, 31, 40, and 50 in. over necking rest; speed can be changed without stopping the roll, simply by turning the hand wheel.
A. Garrison Foundry Co., Pittsburg.

it will stand. When rightly heated and hardened it gives fine service, and takes a good sharp edge.

High-speed steel has not been tried yet for roll turning to any extent, on account of its price; but it would seem that there is a brilliant future ahead for steels containing 4 per cent. of nickel and also 5 per cent. of chromium. It is a well-known fact that all tools must be harder and tougher than the material they are turning in order to do cutting. When they are nearly matched for hardness, the tool has to be ground very often, thus delaying the work, and adding to the expense. Very few employers seem to realize this, thinking that "any old thing will do," and buying cheap steel. The hardest materials the roll turner has to turn are chilled iron rolls, these being nearly as hard as the tool used to turn them, and nowhere does poor steel show to such a disadvantage as in turning this class of rolls. Low-grade steel when used on chill rolls loses its edge rapidly, and when used for finishing a groove, the edge also breaks out and makes fine hair-like lines on the finished work. It does not produce truly circular work on account of its being unable to keep a sharp cutting



60-INCH ROLL LATHE WITH VARIABLE-SPEED COUNTERSHAFT ON THE HEADSTOCK, TURNING A 42 BY 152-INCH PLATE ROLL.

Bed 30 ft. by 5 ft. 7½ in.; 20 in. high; 19 ft. between centers; length of piano rest 15 ft.; of necking rest 36 in.; gear ratio 271 to 1; weight 90,000 lb.; two 12-in. tools can be operated on one plain-face roll at one time. United Engineering & Foundry Co., Pittsburg, Pa.

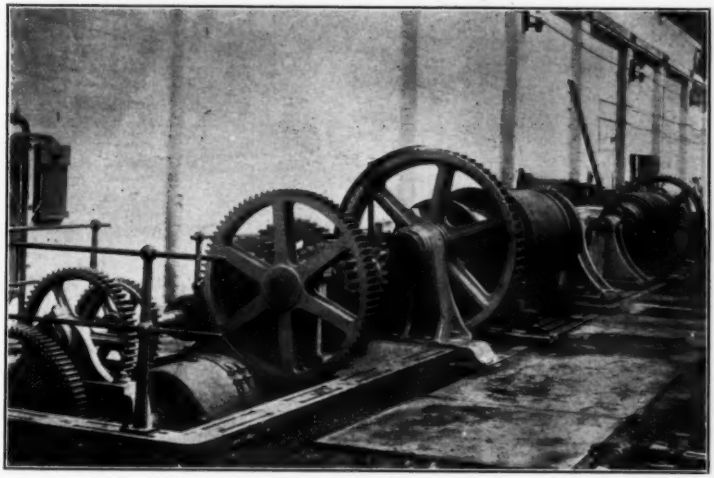
edge, it being necessary to use very sharp tools in finishing work. Nickel steel possesses great toughness and hardness, being about 45 per cent. tougher than the best grades of tool steel sold in the market. High-carbon nickel steel would make most admirable tools for chill work, on account of having the above mentioned qualities.

There are two stages in roll turning, one called "turning" and the other "dressing." Turning is the making of new rolls out of the rough castings as they are received from the foundry; new ones do not have to be turned every day in ordinary sized mills, although in large ones they always keep some journeymen on new work.

Roll foundries turn out rolls finished all ready to be put into the mill, as well as castings in the rough. They giving employment to quite a number of workmen. After the rolls have been a while in the mill, the grooves become rough and worn by the constant friction of the metal rolled, and need to be sent to the lathe to be put in shape. The roll turner takes off just enough metal to true them up, so that they will turn out smooth product again. This is called "dressing." The amount of cutting required varies greatly, depending chiefly on the kind of metal in the roll, length of time it has been in mill, and the character of the metal rolled.

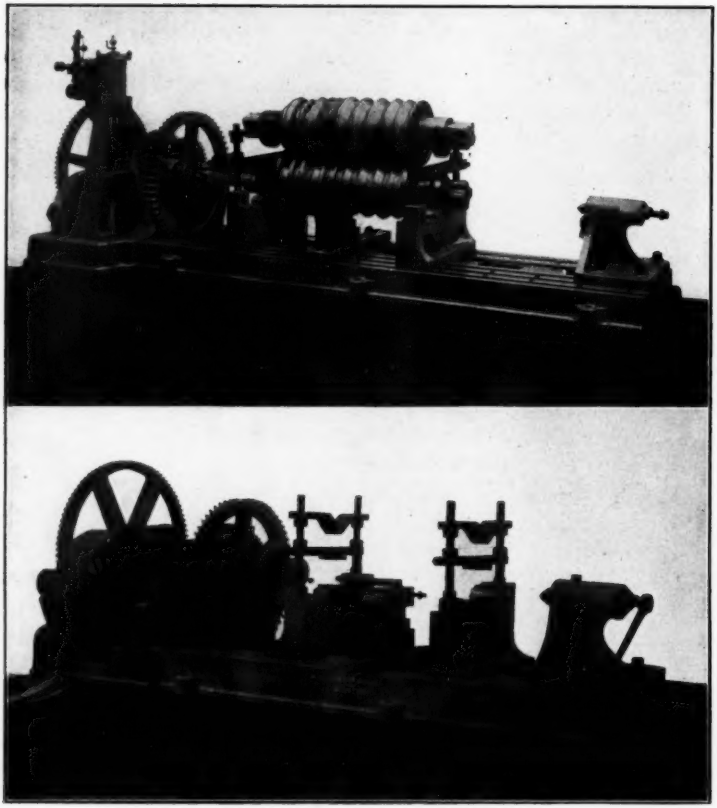
By frequent dressing the rolls get smaller until they are too small for the mill; they then go to the scrap heap and are replaced by new

ones. As a general rule they earn thousands of dollars for the company before being consigned to the scrap heap, although it does occasionally happen that a new roll breaks in two, or has a neck twisted off after a few hours of use. The rolls that are mostly in use by the mills are sand, chilled, semi-steel and steel rolls. Each of these kinds has its good qualities and its particular use for certain purposes. Sand rolls are made by pouring the metal into a mould made in sand, the best ones being made of gray mottled iron; this is a material that gives most excellent results when used for making bar-iron rolls, etc. Chilled iron rolls are made by casting in a metal mould; when the molten iron comes into contact with the sides, it cools quickly on the outside to a depth of 1½ to 4 inches and over. Chill depth depends upon the size of the rolls and the material they are to make, it being the usual practice of foundries to leave the center soft and tough, so as to prevent breakage, or twisting off of the necks. The characteristic of this class of rolls is their extreme hardness, a file making no impression on them. But the best ones are made just so hard that a first-class center punch will make a mark, and no more. This gives a degree of toughness to the dense, brittle material, and helps to some extent to prevent the rolls from breaking so readily. These



A LARGE ROLL LATHE, WEIGHING NEARLY 100 TONS, WITH VARIABLE SPEED DRIVE FOR VARIOUS KINDS OF ROLLS.

Bed plates 50 ft. long, 6 ft. wide, 15 in. deep; headstocks 42-in. centers; takes rolls up to 6 ft. in diameter, with necks from 12 to 27 inches diameter, and 50 tons in weight; cutting speeds from 36 to 300 inches a minute; each end driven independently by 15-horse-power motor. R. B. Tennent, Ltd., Coatbridge.



EXAMPLE OF ENGINE AND BELT-DRIVEN ENGLISH ROLL LATHES.

The upper one has main bed 12 ft. long, 3 ft. wide and 9 in. deep, weighing about 2¾ tons; two change speeds; turns rolls up to 20-in. diameter collars. The lower is 14 by 4½ by 1 ft. bed, weighing 5¼ tons, capable of turning rolls up to 28-in. diameter of collars; driven by 6-in. belt on 3 ft. 3 in. pulleys at 152 revolutions; three change speeds. Both are by Thomas Perry & Son, Ltd., Bilston.

rolls are used to a great extent for finishing work, the grooves keeping their shape quite a while before requiring dressing. In using them care must be taken that no cold bars are run through, as pieces of the groove are liable to break out, thus ruining it for future use.

Steel rolls are used where great toughness with a moderate amount of hardness is needed; they are used for roughing, and also for shapes having delicate points, such as "finger bars," etc. They should be made of steel containing very small quantities of sulphur

and phosphorus. The following is the analysis of a pair of open-hearth steel rolls that comes very near the ideal of what such rolls should be. In actual work they stood the battering acting of heavy manganese-steel ingots of all degrees of hardness for nearly sixteen months, and were then relegated to the scrap heap because they became too small for the mill.

Carbon combined	.49
Silicon	.211
Phosphorus	.041
Sulphur	.036
Manganese	.68

The mill should be so constructed and equipped with labor-saving machinery (and also with powerful engines) that there need be very little rehandling of coal, etc. Modern American mills are splendid examples of this, being operated with very few men and producing large tonnage at a minimum of expense. The up-to-date mill has a special shop for its roll turners, well lighted and so arranged that it can be warmed to a comfortable temperature in the winter.

Any one passing through a roll shop and observing a roll turner at work naturally concludes that he has a "snap"; nothing could be further from the truth, as he has a lot to contend with. Iron, steel, and copper work differently in various mills; this is due to the varying amounts of power provided to drive the train of rolls, and also to the way the material is heated for making finished stock.

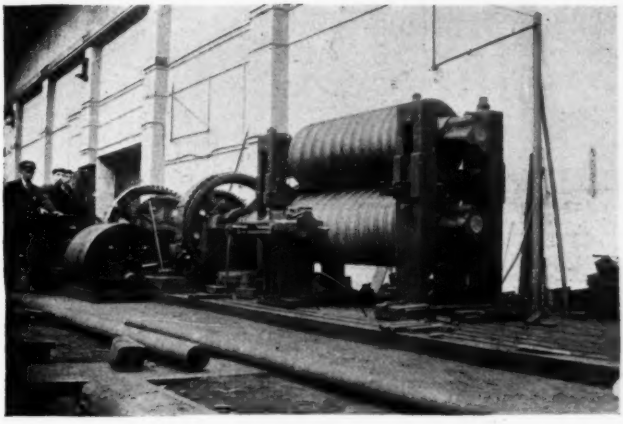
Rolls that work well in one mill will not work well in another, as some mills are very weak in engine power; therefore the drafts of the rolls have to be eased, etc. The roll turner has to be continually on his guard when he works in various places. However, the advantages that accrue from working in different mills are not to be gainsaid. As each one turns out a different line of product from the other, the roll turner who works in various mills gets skilled in every variety of work, and thus renders himself fit to take a "foreman" position, as the foreman must be a man skilled in designing and turning various kinds of rolls.

Many do not seem to recognize this fact, and stay at one situation all their lives, thus becoming specialists in their line of work, but rising to no higher position or wages than a journeyman gets. This accounts for the fact that some men are able to do only sheet work and others wire work, etc. Travel also broadens a man, as he is bound to come into contact with people of different dispositions, and overcome many difficulties in roll turning, thus learning self-control.

It is equally certain that he will get into some mills of an antediluvian pattern if he gets his situations by advertising. Considering the bad roll lathes and tools that some of these mills contain, it is surprising that the roll turner can turn out anything like decent work at all. Some lathes are so worn in gearing and bearings that they can be heard a square away. The housings are so broken and patched that they do not stay long in line with the bed, but twist and spring one way or the other, when a decent cut is being taken. Add to the above a roof that lets the water in onto the roll and lathe when it rains, and a condition is met with that taxes the patience and moral fibre of the roll turner. Some other firms put the lathes in the mill near the roughing rolls, the result being that the workmen stands a first-class chance of having an eye destroyed by flashes of hot metal from the rolls. Other parties have the "happy" (?) faculty of placing the roll lathe in the darkest part of the mill, and then generously allowing their roll turner to use a couple of small miners' lamps, each holding about two ounces of oil. These supply barely enough light in a dark mill to allow the workman to see where the point of the tool is going. In addition to all this, the journeyman generally freezes in the winter and roasts in summer.

In some of these old-fashioned mills, equally strange methods are used to put large rolls into the lathes, one of the most curious of these being the use of a large ship's capstan. This was situated about 50 feet away from the lathe. Above the latter, fastened to an I-bar, placed at a right angle to the lathe, and extending 6 feet in front of it, was a traveller, fitted with two ordinary ship's blocks. Located on the floor and secured firmly to a post was another block. A 2-inch rope extended from the capstan along the ground to the sheave of the block on the floor, and thence to the blocks fastened to the traveller over the lathe. The lower block on the traveller contained a large hook on the end. The method of procedure in putting in a roll was as follows:—the roll was placed by means of crowbars in front of the lathe; a chain with a ring in the middle and two hooks on the ends, was attached, the ends of the chain being placed around the wobblers, and the hooks run through the chain, thus holding the roll securely. The hook on the overhead block was run through the ring, the capstan bars manned by eight negroes, and the roll hoisted higher than needed. The traveller block holding the roll was pushed in until it was over the lathe, and the roll then lowered into place.

This method of doing business was exceedingly dangerous, as the rope was old and had many of its strands unravelled. Had that rope

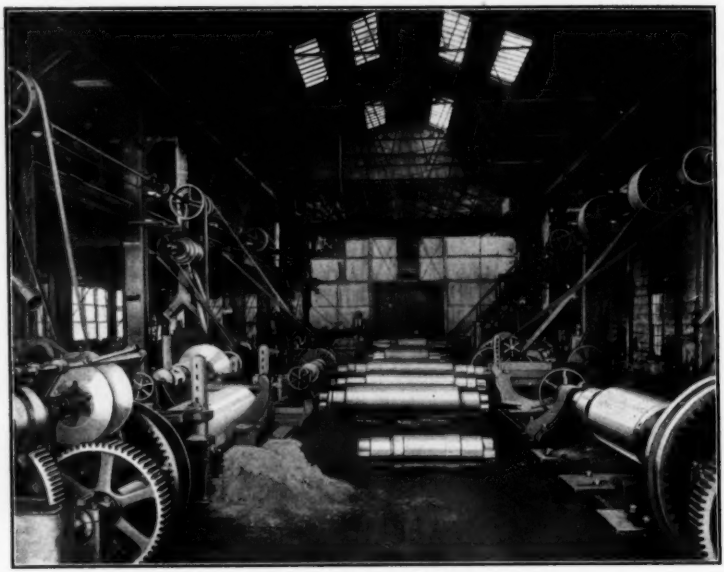


ELECTRICALLY DRIVEN COMBINED DOUBLE ROLL LATHE.

Each fitted on an independent bed plate, 19 ft. by 4 ft. 8 in. by 12 in.; headstocks 27-in. centers; both driven by one 20-h.p. motor; will turn anything from a guide mill roll to an 18-ton plate mill roll. R. B. Tennent, Ltd., Coatbridge.

broken it is most likely that some of the men working the capstan, and also those around the lathe, would have been killed or hurt. Another mill had its rolls put into the lathe by means of an inclined plane, they being rolled up it by workmen with crowbars; one man also kept placing wooden wedges to hold the roll, while the others secured another hold with the bars. When it arrived on the lathe rest it was rolled into position. One firm had a method of putting rolls into the lathe by means of jacks and a cribbage of railroad ties. This was accomplished by raising the roll by the jacks, then placing the ties under, letting the jacks down and taking a fresh hold and putting more ties under the roll. This performance was repeated until the roll was at the requisite height; it being then rolled into the lathe. It is most likely that such crude ways of doing business and wasting time will be done away with in the future, even in small mills.

A rolling mill should be erected where ample shipping facilities can be had, both by rail and water, it being of the utmost importance that the mill should have a free supply of water to cool the rolls and for condensing purposes. Some manufacturing plants are in such a location that they have to pay the water-works for all they use. This



ROLL-TURNING SHOP OF THE LINCOLN FOUNDRY.
United Engineering & Foundry Co., Pittsburg.

adds considerably to the expenses of operating, and should be avoided. Another thing that ought not be overlooked is the fact that steel works, etc., should not be built in a town of less than 5,000 inhabitants, on account of the difficulty of keeping the skilled men, as the latter generally do not care to stay in small country towns where there are very few places of recreation. This is the reason why employers have such difficulty in getting skilled men to remain long in towns containing few inhabitants. Owners of mills prefer to have their plants in such localities on account of the taxes being low, but they do not take into consideration the above mentioned facts, finding them out later by experience.

The influence that new inventions and improvements exert upon the roll turning trade is most important, some of the shapes that the inventor creates calling for the utmost skill on the roll-turner's part in designing rolls, in order that the section may be rolled.

From the foregoing it may be readily seen that the roll turner holds a most important position in regard to helping to add to the comforts that the civilized nations enjoy, his being a trade that will probably last until the end of the world.

THE FIRST EXPERIMENTAL GAS-ENGINE-DRIVEN BOAT.

THE GAS ENGINE FOR MARINE MOTIVE POWER.

By Dr. Alfred Gradenwitz.

The rapid development of the gas engine, outstripping the highest estimates of its most enthusiastic advocates, naturally leads to the consideration of its applicability to marine propulsion. It is in that field that its possibilities of increased efficiency from equal fuel consumption attain their highest potential importance. Dr. Gradenwitz presents a comprehensive review of all that has been accomplished so far in this line of work, and of the mechanical principles involved.—THE EDITORS.

THE problem of constructing gas engines for the operation of ships is receiving much attention at the present moment, and pioneer work done in this line in Germany would seem to be especially noteworthy. It is a well-known fact that steam engines, in spite of the continual improvements in their construction, effect but a rather imperfect utilisation of fuel; nor does it seem likely that an efficiency much higher than 16 per cent. should ever be obtained by marine steam engines, either reciprocating or turbines. On the other hand, it is obvious that a utilisation as perfect as possible of the fuel is of special importance on board ships, where the amount of coal carried constitutes a heavy charge and calls for an increase in the dimensions of the vessel, involving in turn the necessity of a higher power and great coal store, and so on. This point assumes especial importance in connection with warships, where the

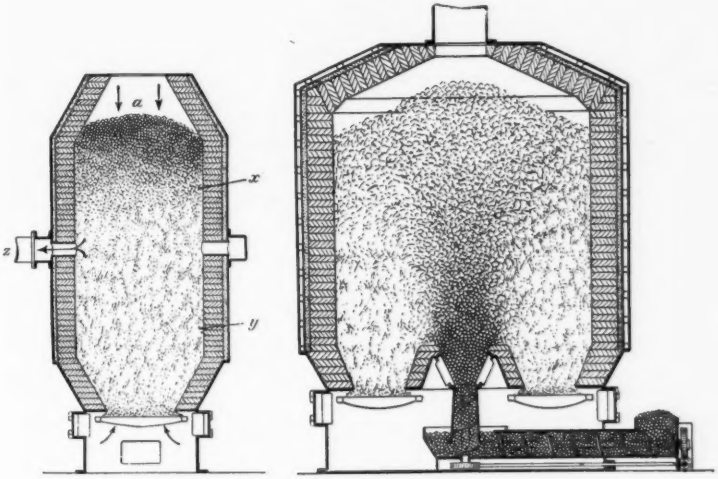
TOWING BARGE DRIVEN BY GAS ENGINES.

radius of action necessarily depends on the amount of coal carried. It may safely be stated that an engine requiring only half the amount of coal necessitated by present-day steam engines would enable the radius of action of these ships to be raised to about twice its value.

The increasing installation of gas motors in connection with stationary operation necessarily suggested the idea referred to above, of using the same type of prime mover also for the propulsion of ships. Internal-combustion motors, mostly operated by liquid fuel, have, it is true, long been used with small sized boats, and even as auxiliary engines in large river barges and sea-going ships. But any gas engines which so far have been used for this purpose were merely heavy units, identical with those constructed for stationary operation, no endeavors being made to adapt them for their special use.

In the stationary gas producer, the production of tar in connection with the gas is a matter of minor importance, since there is no difficulty in employing condensers to separate and remove the tar before the gas is delivered to the engine. On shipboard the addition of a condenser adds materially to the weight and bulk of the apparatus, and yet it is important that no tar should be allowed to reach the engine, because of its injurious effect on the working parts. In the marine gas producer, therefore, it is necessary to regulate the production in such a manner as to convert the tar entirely into non-

condensible gas. This is effected by the arrangement shown in Figure 1, in which the fuel is so disposed as to form two gasefication layers, one above the other, the gas being taken off at the middle. The coal is charged at *a*, and the separation of the tar takes place in the upper layer, the separated tar passing down through the lower stratum of incandescent coke, where it is dissociated by the heat and fixed as permanent gas. Air and steam being delivered into the ash-pit below the grate, there is generated in the lower part of the producer a semi-water-gas, consisting of carbon monoxide, hydrogen from the dissociated steam, and inert nitrogen, this mingling with the gas formed from the tar, and passing out at *Z*.



FIGS. 1 AND 2. TYPES OF MARINE GAS PRODUCERS.

As, however, the use of the two superposed layers increases the height of the producer, this construction has been modified by Capitaine as shown in Figure 2, where the tar likewise traverses an incandescent layer, but of smaller height. The coal is fed mechanically into the producer pit from below and raised to incandescence under a supply of air, while the separated tar is made to traverse the superposed high layers of incandescent coal. The fresh coal being thrown upwards violently, its mechanical crushing is readily effected, the incandescent coal preventing by its motion the formation of solid slag.

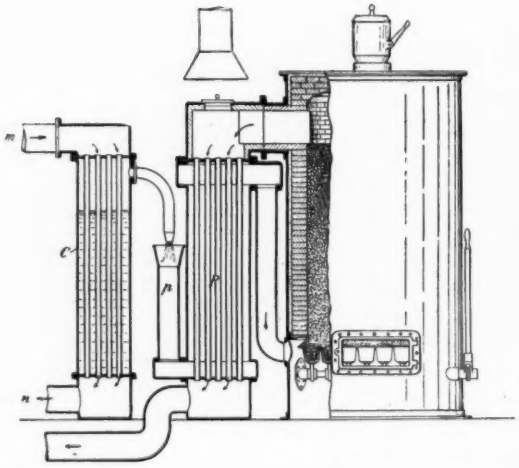


FIG. 3. GAS PRODUCER UTILISING THE HEAT OF THE ENGINE EXHAUST IN THE VAPORISER.

As a further step toward increasing the efficiency of the producer, the heat of the exhaust gases from the gas motor has been utilised to advantage for raising the steam necessary to the producer. In Figure 3, B is the steam producer, into which the hot exhaust gases coming from the gas engine are introduced at *m*, giving off their heat to the heating tubes and escaping into the open through the tube *n* which is at a low temperature. The steam evolved, being mixed with air, flows through the pipe *p* into the heater P, where the heat from the hot gases arriving from the generator is transmitted to the steam-and-air mixture, so that the latter reaches the incandescent coal of the producer in a highly pre-heated condition. If the two heat-exchanging devices C and P are well designed, the efficiency of the producer may be so augmented that from 90 to 95 per cent. of the heat contained in the coal is recovered, in the state of chemical energy in the gas produced.

The amounts of water required for the steam to be decomposed in the producer are as a minimum .20 kilograms in large plants for each effective horse power hour, assuming the coal consumption per horse power hour to be .36 kilograms, while in more advantageous cases they exceed the weight of the coal used. As there is no possibility in gas engines of recovering water by condensation, these amounts of steam must be generated directly from the water of the river.

In the case of sea water, an ordinary vaporiser such as represented in Figure 3 cannot be used, the residual salt giving rise to rapid incrustation. In order to avoid this, a special vaporiser has

been constructed (Figure 4) in which the concentration of the sea water can never exceed a given degree. This is effected by a continuous passage of water through the steam generator, the fresh water entering at *a*, flowing upwards through the coiled pipe *t*, whence it enters the steam generator, where the concentration of the water is increased up to 3 to 4 per cent. by vaporisation. A continuous discharge of saturated hot water in the compartments then ensues, its heat being given off to the coil and heating the fresh water. If the heating surface of the coiled tube be adequate, the loss of heat due to the continual passage of water is extremely low. The working of such sea-water vaporisers is continuous, no cleaning being required, except at very great intervals.

One of the greatest difficulties experienced in the use of gas producers for the operation of ships is the fact that the temperature in the producer decreases in the case of a temporary stoppage, or if the engine works at half its output, so as not to allow of its resuming full duty immediately afterwards. The greater the dimensions of the producer, the longer will the proper temperature be maintained in the interior even in the cases just referred to, while in the smaller types of producers (up to 150 horse power) the fall of temperature is relatively rapid.

This problem has been solved in a double way by Mr. Capitaine. In the case of reduced gas consumption, the coal is gasefied only in such layers as have an outside transmission of heat, while on the other hand the producer is heated by its own gas as long as it is not warmed sufficiently by a normal gas consumption.

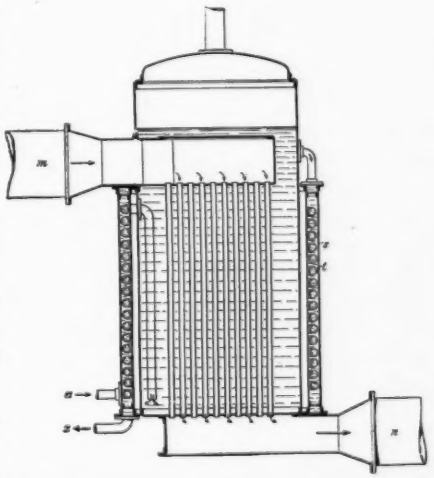
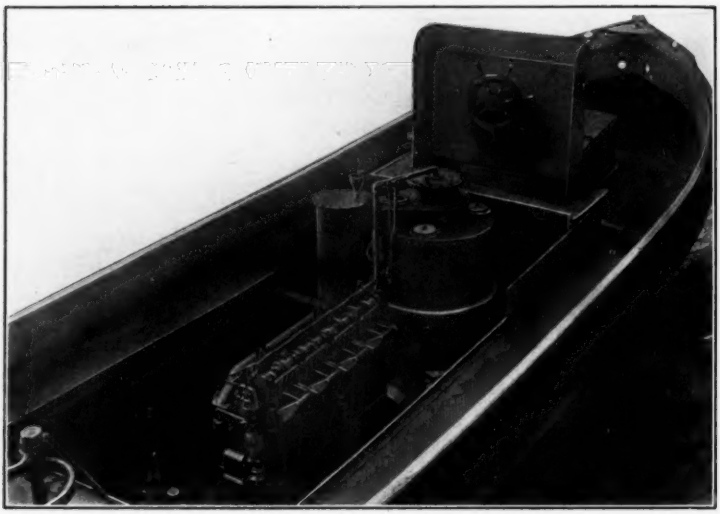


FIG. 4. VAPORISER FOR USE WITH SEA WATER.

As regards the type of motor developed by Mr. Capitaine, the four-cycle type with two or four cylinders has been adopted, while the use of quick-running engines has been avoided, the principal



SHOWING THE SPACE OCCUPIED BY AN 80-HORSE-POWER MARINE GAS ENGINE WITH ITS PRODUCER.

point sought being solidity in design. In the smallest type of marine gas engine (20 brake-horse-power) the number of revolutions is only 380 per minute as a maximum, being 320 with 40 to 80 brake horse power, 220 with 150 brake horse power, 180 with 300 brake horse power, and finally only 120 revolutions for the larger outputs (500 to 1,000 brake horse power). Figures 5 a, b, c, d, show a four-cylinder engine of 80 brake-horse-power maximum output, while pages 348 and 352 show a hauling barge fitted with this engine, and page 347 represents the first experimental gas boat (of 25 brake-horse-power output) that has been operated by marine gas engines proper.

Single-action cylinders have been chosen on account of the higher safety in working warranted by such engines, all the working parts being more easily accessible, the engine being lower and the reciprocating masses smaller. By using four cylinders, as indispensable for a uniform running in connection with a small flywheel, the dimensions of the motor housing are relatively great. Instead of screwing the cylinder gland to the cylinder, as is ordinarily done, the cylinder A (see Figure 5) is fixed to the cylinder gland—i. e., the combustion chamber F. In order to disconnect simultaneously the cylinder with the piston valve from the interior of the combustion

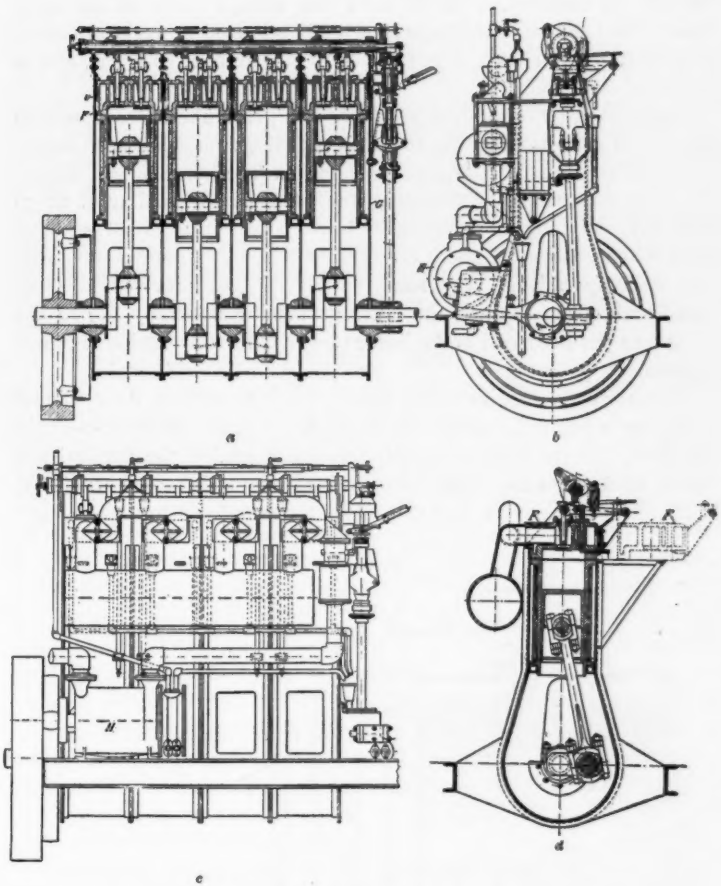


FIG. 5. FOUR-CYLINDER 80-HORSE-POWER MARINE GAS ENGINE.

chamber, there are only four comparatively small bolts to be loosened.

The body of the motor is made of sheet iron, giving a minimum weight with maximum strength. In order to clean or to overhaul the cylinders, pistons, and working parts, there are no other parts to be removed.

The timing of the ignition should be altered according to the varying numbers of revolutions, in the case of slow-burning producer gas; this is effected by the regulator, shifting automatically

the time of ignition, so as to have this always occur at the most favourable moment. The regulator being adjusted by hand in course of operation, the engine is adjustable to any number of turns, and is regulated economically.

The consumption of coal per hour and per brake horse power in the case of a 10-horse-power motor is 0.5 kilograms, with a 30-horse-power motor, 0.40 kilograms, and with a 100-horse-power motor, only 0.36 kilograms. Calculating the price of the coal used at 50 cents per 100 kilograms, the brake horse power in a 30-horse-power plant will work out at about 0.2 cents per hour. There is obviously only a comparatively very small supply of coal required as compared with steam engines, the latter consuming generally 1½ to 2½ kilograms per hour and brake horse power with 10 to 20-horse-power engines.

A marine gas engine of 25 horse power requires a floor surface of 800 by 1,900 millimetres and a height of 1,300 millimetres above the floor. In the case of a 50-horse-power engine, the vertical and lateral dimensions are exactly the same as in a 25-horse-power motor, while the length is augmented by about 700 millimetres; the weight

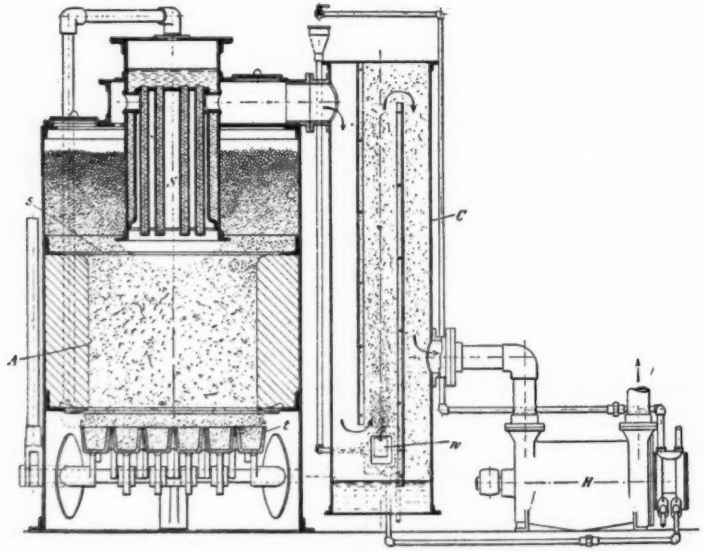


FIG. 6. PRODUCER PROPORTIONED TO THE 80-HORSE-POWER ENGINE SHOWN ON THE PRECEDING PAGE.

is only about 25 per cent. greater than that of the 25-horse-power motor.

The motors are started by compressed air in the well-known way, for which purpose a small compressed-air tank is fitted below the floor. The 25-horse-power motors have two cylinders, while those of from 50 to 400 horse power are fitted with four cylinders. In the case of twin-screw boats, using two 400-horse-power engines, a maximum output of about 800 horse power is secured by the new motor. For starting the motor and blowing in the producer a small auxiliary engine is provided, operated by benzine or petroleum; this seldom works for more than a few minutes per day.

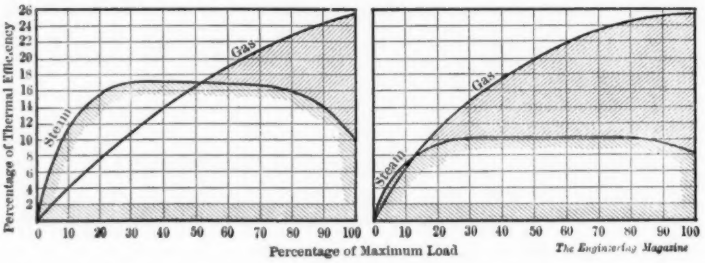
An 80-horse-power producer corresponding to the engine shown in Figure 5 is represented in Figure 6.

It has so far been impossible, in small-sized producers (of less than 300 brake horse power), to use ordinary bituminous coal without inconvenience, so that anthracite and coke have still to be used. The producer represented in Figure 6 is designed for anthracite operation, the steam generator S lying immediately above the incandescent layer and being surrounded by the coal, which constitutes a rather perfect heat protector; this coal falls through the annular slot *s* into the gasefication pit A. The grate consists of trough-shaped bars t, which, being filled with ashes, offer only a very small contact surface with the incandescent coal but a very large radiation surface downwards. Experience has shown this grate not to be affected by superheat even when highly pre-heated air is used.

The produced gas, passing through the vaporiser S, enters the cooling and cleaning vessel C, where water is divided as finely as possible by air and a vaporiser *n*, and so to say, transformed into a cloud. The surface offered by the water to the gas is thus greater and the contact of the water and gas more intimate than has heretofore been effected in so small a space.

The cloud formed in the gas by the novel vaporisor *n*— i. e., the intimate mixture of water and gas—is led into a specially constructed centrifugal device, H (see Figures 5a, and 5c) driven by the engine, where it is submitted to an extremely energetic centrifugal effect with about 100-metres peripheral speed per second, when the water particles are separated perfectly from the gas, together with any tar and ash particles suspended in the gas. Some amounts of solid sulphur are likewise separated in the centrifugal outfit, so that the gas is brought to a state of purity quite sufficient to warrant safety in operation.

In a lecture recently delivered before the German Society of Naval Engineers (*Schiffbautechnische Gesellschaft*), Mr. Capitaine offers the following suggestions on the economic side of the operation of marine gas engines:—The undoubted superiority of gas engines over steam engines in regard to thermal efficiency, holds true only as long as the load approaches the full figures, while in the case of reduced performance, the thermal efficiency is found rapidly to decrease, becoming about identical with that of a stationary steam engine with 50 per cent. load.


Percentage of Thermal Efficiency
Gas
Steam
Gas
Steam
0 10 20 30 40 50 60 70 80 90 100
0 10 20 30 40 50 60 70 80 90 100
Percentage of Maximum Load
The Engineering Magazine

FIGS. 7 AND 8. DIAGRAMS OF THERMAL EFFICIENCIES OF STEAM AND GAS ENGINES.

In Figure 7 the diagrams of thermal efficiencies have been drawn both for a gas engine and a highly perfected stationary steam engine, supposing the angular speed to be constant. In the operation of ships, the gas-engine curve will, it is true, prove somewhat more advantageous, the reduced output involving a decrease in the number of revolutions—that is to say, a diminution of the frictional work—so that the curve, as shown in Figure 8, becomes steeper. On the other hand, the curve of steam engines fails to attain the height represented in Figure 7 for the case of stationary engines. While a thermal efficiency of 17 per cent. seems hardly ever to have been secured in connection with marine steam engines of the greatest outputs, smaller types of about 100 horse power are known to use about 1 to 1.2 kilograms coal of 7,000 degrees C for each brake-horse-power hour, giving a thermal efficiency of less than 10 per cent. A characteristic feature of steam engines is the fact that their thermal efficiency becomes lower as their output is smaller, while present-day gas engines show practically an opposite behaviour.

From the above, the great superiority from a thermic point of view of marine gas engines with smaller outputs will be evident; and though the price of anthracite and coke be about 50 per cent. higher

than that of the coal used for the operation of steam engines, the economical advantage will still be quite material, the cost of fuel in a gas engine of 100 brake horse power, for instance, being less than half that of an equivalent steam-engine. As the output increases, the economical superiority of gas engines as compared with steam engines is found to increase as far as the limit where anthracite and coke can be replaced by cheap coal, when the profit at first increases again, to become problematic with about 1,000 brake horse power, owing to the difficulties inherent in ship operation. At all events, the saving in weight and in space as compared with rationally working steam-engines remains considerable up to 1,000 horse power.

As regards the steering of marine gas engines, which is one of their weak points, Mr. Capitaine uses either an adjustable screw of the Meissner type or an inverting gearing, while for outputs of more than 200 horse power neither of these devices proves satisfactory, and steering by compressed air, inverting the sense of rotation of the engine-shaft, is being resorted to.

As the power of the engine increases, the mass of the flywheels required will augment to an extraordinary degree. In fact, the higher the output of the motor the greater will be the stroke and the larger the reciprocating masses, such as the piston and connecting rods. As in the operation of ships the use of heavy foundations, as usual in stationary operation, is quite out of the question, while oscillations should be strictly avoided, a speed of the piston of upwards of 4 metres would seem to be quite impracticable; this would involve a low angular speed in connection with relatively small cylinder bores and long piston strokes. If the number of revolutions be diminished still further, as would be the case with slackened speed, present-day gas engines would prove extremely unsatisfactory in working, the extremely hot gases being allowed to pass on to the cooled walls, i. e., to cool down.

In Figure 9 are shown the diagrams of the high-pressure cylinder of a triple-cylinder expansion steam engine and of a gas engine, while Figure 10 shows the dimensions of the

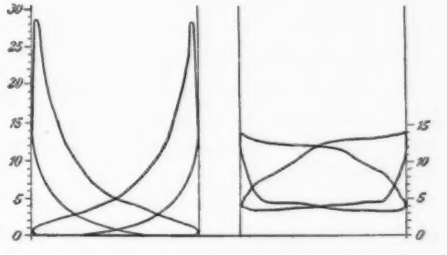


FIG. 9. INDICATOR DIAGRAMS OF TRIPLE-EXPANSION STEAM ENGINE, (HIGH-PRESSURE CYLINDER) AND OF GAS ENGINE.

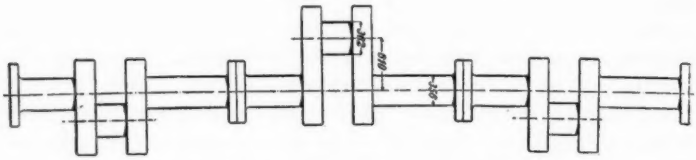


FIG. 10. CRANK SHAFT OF MARINE ENGINE OF 2,000 HORSE POWER.

crank-shaft of a marine steam-engine of 2,000 indicated horse power with 75 revolutions. It will be seen that the maximum pressure of the steam engine is about 15 atmospheres, with a useful average pressure of 6.8 atmospheres, while the maximum pressure of the gas engine should be taken at 30 atmospheres, the useful average pressure being, however, no greater than that of the steam engine. This shaft, which has been calculated for a 2,000 indicated-horse-power steam engine, would, for the same number of revolutions, be suitable only for a gas engine of little more than 1,000 horse power, even in case six cylinders are arranged in pairs.

Present-day gas engines are, according to the above, in a position to compete with steam engines in the operation of ships only as far as concerns outputs of less than 1,000 brake horse power (or 2,000 electrical horse power in the case of twin-screw).

The suitability of the Capitaine gas engines has been borne out already by trials of small-sized boats, while Messrs. William Beardmore & Co., Ltd., of Glasgow, and John I. Thornycroft & Co., Ltd., London, have undertaken the construction of a four-cylinder marine gas engine of 600 brake-horse-power output (to be possibly increased up to 900 electrical horse power, corresponding with a steam engine of 1,000 indicated horse power), so that a definite demonstration of the practicability of gas ships can be anticipated for the course of this year.

The economical bearing of a possible introduction of gas ships can hardly be underrated, allowing as it would of many millions being saved in coal, so that the waterways, owing to the cheaper gas operation, might become much more powerful competitors to railways than heretofore.

THE GENERAL STORES-KEEPING DEPARTMENT OF THE BROWNING ENGINEERING CO.

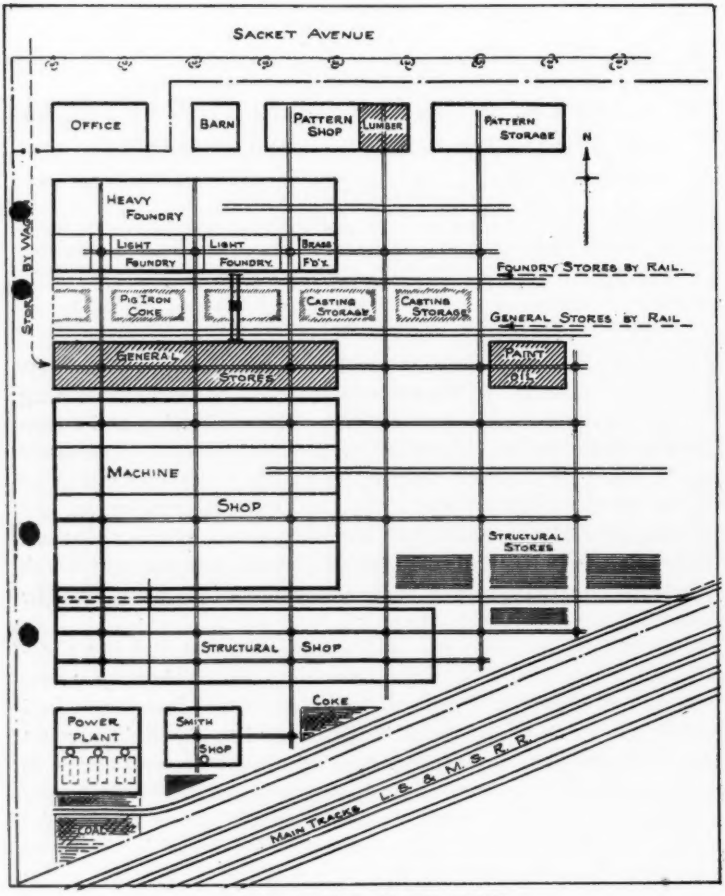
By Earl Harrison Browning.

Mr. Browning's article is the third in the series descriptive of stores-room systems in actual use, the purpose in each case being to have the account given by an administrative officer directly in contact with the working of the shops. Mr. Browning is the works manager of his company, which manufactures traveling and locomotive cranes and hoisting machinery. Preceding articles in the series have described the methods of the Pond Machine Tool Works and the National-Acme Manufacturing Co.—THE EDITORS.

IN the modern plant of today for the manufacturing of machinery, the responsibility of the business is generally distributed among the managers of the administrative, financial, sales, and manufacturing departments. The work of the manufacturing department may be again divided and assigned to as many sub-departments as may be found necessary for the rapid and economic production, and it is now generally conceded by the modern works manager that one of the most important of these sub-departments is the one which collects the material necessary for the operation of the plant, or "The General Stores-keeping Department."

It was early demonstrated to The Browning Engineering Company that the only possible way to prevent constant shortage, to reduce the stock to a minimum, to keep a perpetual inventory of all material on hand, to insure its being charged to the right account when delivered, and—most important of all—to prevent delays in the manufacturing departments by having ready to deliver the proper material when required, was to create a general stores-keeping department for both finished and unfinished material used by the entire plant, and (in order to locate the responsibility) to place this entire department in charge of a general stores keeper, and give him a sufficient number of clerks and laborers to keep the records and handle the material, and relieve, absolutely, all other employees.

The large variety of materials to be handled made it impossible to adopt any one method of storing them which would meet all conditions satisfactorily. While some were not materially damaged by a short exposure to the weather, others would be ruined by the least moisture. There were light and heavy, long and short, wide and narrow pieces; some were regular and piled up nicely, and some



A GENERAL PLAN OF THE WORKS.

Showing central location of General Stores. Paint and oil are stored separately, to reduce fire hazard, lumber and structural stock, and coal and coke being stored where used, to reduce cost of handling.

were frightfully distorted and refused to be arranged with the least semblance of order. There were solids and liquids, some used by only one department and some by all. To meet these varied conditions best, the company decided to erect a building for all the perishable stores that were not especially inflammable; to build a second building for the paints, oils, and combustibles; to inclose a

yard, by means of a high fence, for the storage of small castings and small articles not affected by the weather; and to adopt a system, as here explained in detail, for the receiving, storing, and delivering of the materials.

This system is not intended to be an ideal one to meet the conditions in all manufacturing concerns, but simply the present form of one which best suits the peculiar and particular business of this company.

To distribute the material from this central storage, a system of narrow-gauge tracks is used, by means of which, with turntables and small cars, any department can be reached.

THE GENERAL STORES KEEPER'S OFFICE, DESK, AND RECORD FILES.
The cases are sectional, made of hard wood and of the same dimensions as the stock-room cases. The drawer sections contain the stock records, on cards.

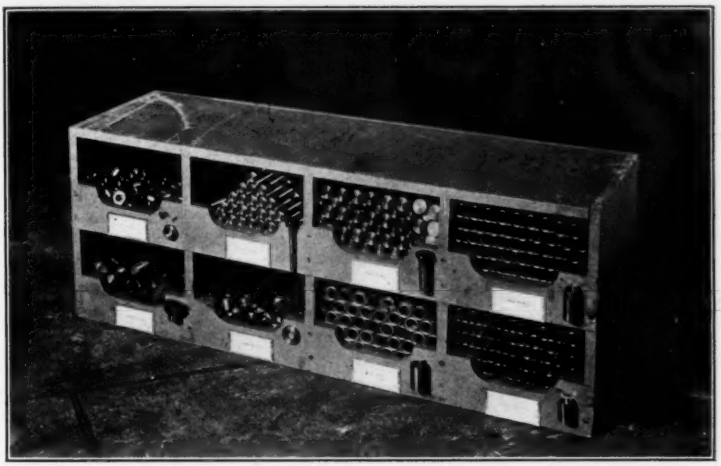
The main stores building is divided into two parts by the office and reserve store room, which are located near the center. In the office all the records are kept in writing and as nearly up to date as possible, neither memory nor individuality being depended upon. The forms upon which the records are kept in all the departments throughout the office and works are of the same dimensions and filed in the same manner. The full-size record sheets are 8½ inches by

A PART OF THE ROOM FOR MATERIAL RESERVED FOR THE FITTING DEPARTMENT. Each of the reserve stock bins represents an order, and all material therein is tagged and completed ready to assemble.

11 inches, with 1 inch margin on the left-hand side, and are perforated to suit the loose-leaf files. The files in daily use are bound in leather and may be quickly opened at any place to remove or insert a page. The files to which this matter is later transferred are plain canvas backs, and are kept in sectional cases as shown in the view of the general stores-keeper's office. The half-size records are

5½ inches by 8½ inches, and are filed in sectional cases of drawers as shown. The ordinary index cards used in the cost and time-keeping departments are filed in drawers in the same manner.

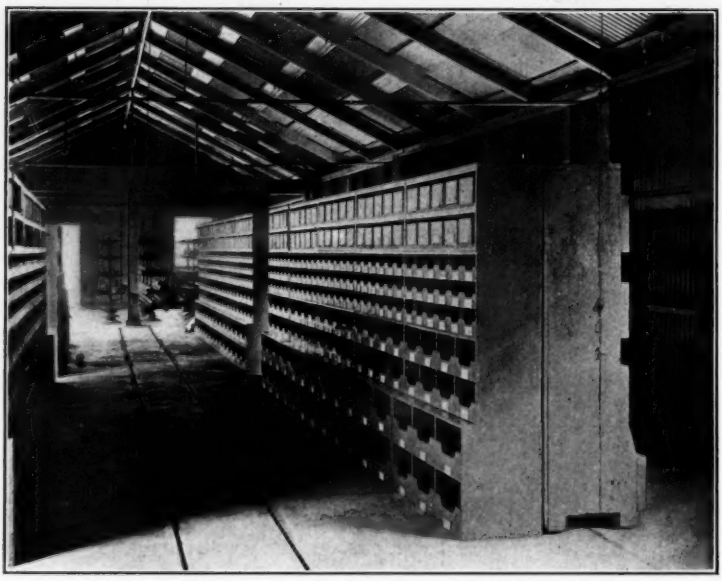
The reserve stock room, from which all material is delivered, is filled with bins for the small material reserved for all the various shop orders until the shop is ready to receive it. Each bin represents the material on one order as described by the card in the pocket. This room is provided with several delivery windows, each one having a call bell to attract the attention of the delivery clerk.



ONE UNIT OF THE SECTIONAL CASE FOR SMALL PARTS.
The card in the slide gives the full history of the piece contained in the bin. These particular parts are engine details.

The larger part of the main building, in which is stored all the crude stock as well as all unassembled finished parts, is equipped throughout with sectional cases, with units 18 inches high by 15 inches deep and 4 feet long, made of wood and having any number of compartments from four to eighteen to a unit. These can be moved, piled, and arranged to suit conditions, and in them are stored all material such as nuts, bolts, screws, cotters, washers, rivets, pipe fittings, springs, and very small castings, as designated by the card in the holder fastened to the front of each compartment. For a few articles there are shelf and drawer units of the same dimensions as the compartment sections. These, with the compartment cases, accommodate almost everything in the main building except the bar material and some miscellaneous supplies.

RACKS FOR STORING BAR MATERIAL.
Tool steel, drawn steel, soft steel, brass rod, etc.; the separate racks are single, on stands, and as many may be used as the length and weight of the stock require.



STOCK BINS, BUILT UP OF SECTIONAL COMPARTMENT CASES.
For small hardware, etc.; each section being a unit, they may be assembled in any convenient form.

For bar stock, pipe, draw steel, tool steel, brass tube, and rods, etc., special individual racks with heavy cast bases, pipe uprights, and cast arms are used. These are portable and can be placed in any manner desired to suit the stock, and the material can be kept cleaner, more accessible, and in better light. The heavier bars are placed on the lower arms, the lighter above. A small hand-power crane runs over all of these, as well as over the cutting-off machines, saws, and pipe cutters, which are located near the racks and are in

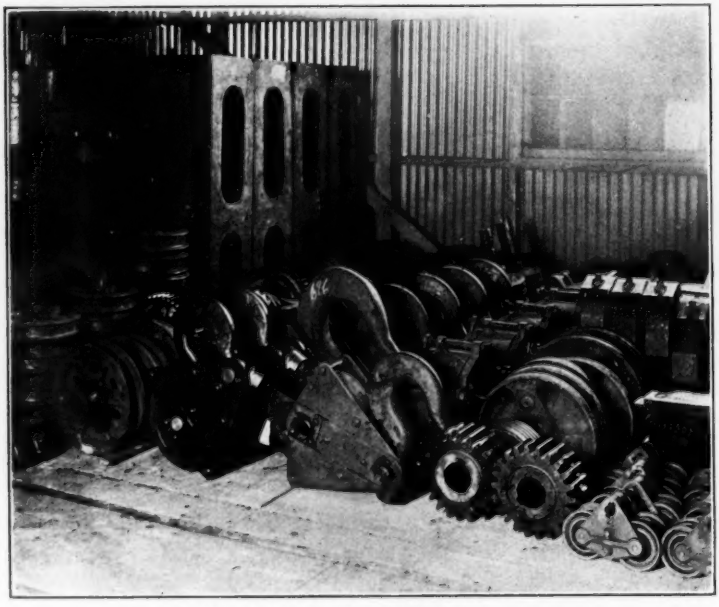
SHELF RACKS FOR STORING MEDIUM-SIZED FINISHED PARTS.
The division pieces on the shelves may be arranged to suit various requirements.

charge of the general stores keeper. For a few miscellaneous supplies special provision is made; for the fire-clay, cement, asbestos, salt, boiler compound, etc., ordinary oil barrels well cleaned, painted, and labeled, with loose covers, are used. For the iron, steel, and brass wire a rack of reels. For the wire rope, block asbestos, chain etc., nothing better has been devised than to pile them up on the floor as neatly as possible.

The unassembled finished parts, such as bushings, special pins, bolts, nuts, small forgings, and castings, are stored in the same sectional cases and are treated the same as the purchased stores, the card in the pocket giving all the information possible to identify it,

such as piece number, drawing number, shop-order number, description, location on machine, and size of machine. To assist further, a sample piece is fastened on the front as shown on page 363.

The remainder of the main building on the other side of the office and reserve stock room is reserved for the finished parts which require no further assembling until the final shipment. These are the most difficult of all for which to provide an adequate and convenient method of storing. The lighter and smaller parts are stored on portable shelves made of the same heavy bases, pipes, and cast arms as used for the bar material. The larger and heavier parts are piled on the floor. These parts are handled in a manner similar to the other stock and are delivered to the assembling floor when orders for shipment are received.



STORAGE FOR LARGE FINISHED PARTS.
Showing the method of piling pieces which are too large to be stored on racks.

The separate building for the inflammable materials, which is some distance from any of the other buildings, is made of corrugated iron laid on an angle frame and provided with a cement floor. For the kerosene, gasoline, and machine oils larger tanks with pumps attached are used to reduce the waste from filling cans.

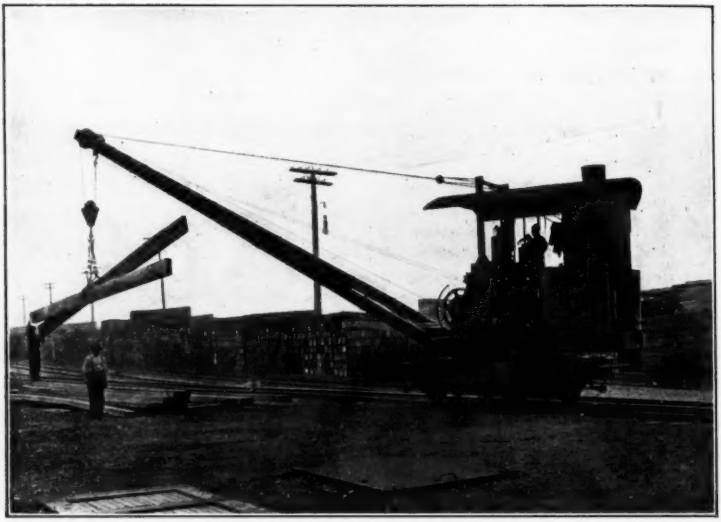
The paint and oil barrels are placed on large benches high enough to raise the barrel gates above the cans. Over these are arranged shelves for the smaller casks and cans and miscellaneous supplies, such as putty, paints, glass, lamp black, etc. No one is allowed to enter this building after dark with any kind of a light except incandescent lamps, which are arranged on extension cords with fuse rosette outside the building.

A PORTION OF THE CASTINGS STORAGE YARD.

All castings of like nature are piled together, in rows wide enough to permit handling the heavier ones with hand trucks.

The yard for the storage of materials which are not damaged by exposure to the weather is located on one side of the main stock building, and extends about twice its length. The one end is enclosed by a high fence and a storage thus provided for the smaller castings and parts, which are arranged in rows laid on boards far enough apart to allow the heavier ones to be handled with a truck. The castings that are liable to remain outside for some length of time are thoroughly cleaned and dipped in oil or painted, but little difficulty is experienced from this source, as the stock is kept as low as possible and on the move all the time.

There are also stored inside this fence such miscellaneous building supplies as are occasionally needed, as, for example, brick, tile, etc. The rest of the storage yard is set aside for the rough castings and



ONE OF THE LOCOMOTIVE CRANES IN THE STORAGE YARD.
A cheap and effective method of handling and storing lumber and heavy castings.

finished parts too heavy to be handled by hand, and is provided with a Browning No. 2 locomotive crane, as shown in the accompanying photograph, running on a standard-gauge track on each side of the yard. The locomotive crane is admitted to be the most efficient method of handling stores, for it not only can load and unload the cars but can be used as a shifting engine for transferring them from one place to another, and when provided with a bucket and operating mechanism can unload coal, ore, sand, and cinders and deposit the material 40 to 50 feet on either side of the track.

At one side of the yard nearest the proposed foundry is a long building, divided by partitions into small rooms for the storage of turnings, borings, cast scrap, punchings and clippings, brass, and copper, each material being kept entirely separate and protected from all other materials required by a foundry.

It was understood from the first that it would be practically impossible to store all of the material used throughout the entire plant in the one place, as the cost of rehandling some of it would amount to considerably more than the advantage gained, while the mere insignificance of others would not pay for the trouble. So while the general stores keeper is held responsible for *all* material used in the works, yet it is necessary in some cases that material be de-

livered to a department and a report of it made to him when used. The coal is delivered direct to the power house, the smithing coal to the smith shop, and the coke to the smith and structural shops, and the whole amounts charged up at once.

The pattern lumber is delivered direct to the dry kilns, and the carpenter material direct to the lumber storage, but a daily account is rendered to the general stores keeper of amounts used.

All the structural material, such as beams, channels, angles, and plates, is stored near one end of the structural shop and handled by the locomotive crane. The foreman of the department makes a daily report of all material used. The rivets, however, are kept in the general store house and are reserved for each order.

The small shop supplies, such as files, emery-paper, chalk, candles, and waste, are given out at the general tool room by order of the foreman, and are charged to his department and a report made daily to the general stores keeper. The office and drafting-room stores are kept in locked cases in the office building, in charge of an office clerk. All stationery, catalogues, envelopes, stamps, etc., are delivered to the stenographers in lots of 50 to 100 as desired. The drawing-paper, tracing cloth, ink, pencils, etc., are delivered to the draftsmen as needed. At the end of each month a report is made to the general store keeper, who makes the proper charges.

The System in Detail.—In all well managed concerns, the orders to begin the manufacture of each article or articles issue from the management and are necessitated by the nature of articles sold or in anticipation of sales. The quantity in which they are ordered depends entirely upon the nature of the product and is based upon: (1) the promised delivery of the articles sold; (2) the probable demand anticipated for any certain length of time; and (3) the measures necessary to avoid a loss of efficiency by a congested condition of any department in the manufacturing.

In The Browning Engineering Company, the orders for parts of machines to be built are fixed by mutual consent of the administrative, sales, and works management, and a copy of the signed agreement is kept by the works manager who issues a card 3 inches by 5 inches, to the engineering, billing, time-keeping, and stock departments, notifying them that certain shop orders have been taken out to build certain new parts. If the order requires the preparation of new designs and drawings, the engineering department is furnished with copies of all necessary information, and as soon as possible it furnishes to the billing and blue-print departments all new drawings

THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO.

Page
Cont. No. Clutch Sp.
S. O. No. 1219
Date 8-10-04
Made by N.E.B.

BILL OF MATERIAL.

For Spiral Spring Travelling Clutch. 10" "Z".

	Sheet Number	Item No	Number of Pieces	GENERAL DESCRIPTION	MARK	SIZE	LENGTH		Kind of Material	Material Received	Material Delivered
	1385	1	12	Sleeves.	1385A				S.C.		8-
	"	2	12	Bushings.	850C				B.B.	10185	8-20-04
●	"	3	24	Dowl pins. Piece No. 1017.		¼"		½"	B.B.	10185	8-11-04
	"	4	12	Helix. R.H.					S.S.	10185	8-25-04
●	"	5	12	Helix. L.H.					S.S.	10185	8-25-04
	"	6	24	Hardened Blocks.					T.S.		
	"	7	72	Cap Screws.		⅜"		1½"	S.S.	10185	8-11-04
	"	8	72	Lock Washers.		⅜"			S.S.	10185	8-11-04
	"	9	12	Grease Cups.		#3.			—	10185	8-11-04
		10									
		11									
●		12									
		13									
●		14									
		15									
		16									
		17									
		18									
		19									
		20									

THE BILL OF MATERIAL.

This is furnished by the billing department, and contains an itemized list of all the parts necessary to make up the order. A copy is sent to the foreman of each department and is not withdrawn until the order is completed ready for shipment.

complete, with memorandum of old ones to be used. If, however, the order is to be an exact duplicate of one previously built, the billing department is able to proceed at once, and from the tracing and blue prints a complete "bill of material" of every piece used is written with hektograph ink and copies furnished to the foreman

of each department. This bill is not only an official general order, but in such detailed form that every single article used is listed out. The bill of material contains all the information that can possibly be given in writing, as shown by the accompanying cut. For each item there is provided by the billing department a "Tag," which is made of heavy linen, reinforced around the hole in one end, made out with water-proof ink as shown, to be fastened to the work while in process of manufacturing, and a "follow card," which is a 3 inches by 5 inches ordinary index card, which follows the work from department to department and is kept in drawers on the desks of the respective foremen in whose departments the pieces lie.

THE BROWNING ENGINEERING CO.
CLEVELAND, O.

SHEET No.	1385	PAGE	1
No. OFF	12	ITEM	2
DESCRIPTION	Bushing		
SIZE	Pat 850 C		
MATERIAL	B3		
CONT.	Clutch Stock	S. O.	1219

THE FOLLOW CARD.

It contains the same information as the tag, and is forwarded from one foreman to another as the work progresses. Half the size of original.

All these tags and follow cards are first sent to the general stores-keeping department, where they are sorted and filed; from the records, a list is made of all material needed to fill the order, and this list in the form of a requisition is then sent to the office of the works manager, and (when authorized) to the purchasing agent, who as soon as it is decided where to purchase the articles writes out an order in quadruplicate. The original order is sent to the firm from whom the goods are purchased; two copies remain with the purchasing agent, one filed numerically, the other alphabetically; while the fourth copy goes to the general stores keeper, to identify the material when it arrives. The order is shown on page 374.

The responsibility of the general stores keeper begins with the placing of the order. He has all the teams and wagons at his disposal, and uses his own judgment in sending for materials purchased of local dealers. He keeps a

SHEET No.	1385	PAGE	1
No. OFF	12	ITEM	2
DESCRIPTION	Bushing		
SIZE	Pat 850 C		
MATERIAL	B3.		
CONT.	Clutch Stock	S. O.	1219

THE TAG.

Furnished by the billing department for each lot of articles, and attached to one piece of the lot. Twice this size, made of linen and printed in water-proof ink.

THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO.
CAR RECORD

Made by Fudge — From Jan 1 1904 — To Feb 1 1904

Car No.	Rail Road.	Contents	From or For	Place	Date Shipped	Date Received	Date Ready	Date Pulled Out
41792	P&LE.	Plates	Carnegie Co	Pittsburgh	12-15-03	1-2-04	1-14-04	1-16-04
21076	L&NRR	Pig Iron	Johns & Co	Buffalo	Reload	1-3-04	1-3-04	1-4-04
872	Erie	Bucket	J.A. Fuller	New York	"	1-7-04	1-9-04	1-10-04
593	PRR	Coal	Jeff. Fuel Co	Cincinnati	1-13-04	1-15-04	1-16-04	1-18-04
3390	Ill Cent	Castings	Chicago Dry	Chicago	1-17-04	1-21-04	1-22-04	1-23-04
					"			

THE CAR RECORD.

This record is kept by the general stores keeper, and shows all cars shipped, received, loaded or unloaded, and pulled out. This is quite an assistance in settling demurrage claims.

car record of all cars shipped, and, when they arrive, the exact time unloaded and delivered to the railroad as well. He also has a record of all the patterns, so that the orders for castings may be placed more intelligently, and when it is necessary to move them from one foundry to another he may assist.

THE BROWNING ENGINEERING CO.

CLEVELAND, O.

PATTERN RECORD.

Pattern No. 596K

GENERAL DESCRIPTION Cone Roller for 42 Locomotive Crane.

Wt. Complete	Shrink	NUMBER OF PATTERNS. Metal	Wood	Loose Pieces	NUMBER OF CORE BOXES. Metal	Wood	Loose Pieces	REMARKS
80#	Steel.	X	1	Hour.	X	1	Hour.	Mode. Aug. 7.03

SHEET NO	Contract No.	No. OFF	Mat'l	BUYER'S ORDER NUMBER	DATE SENT	SENT TO	DATE RETURNED	REMARKS
596		10	S.C.	9125	Sept 1. 03	The Sharon Steel Cast Co.	Oct 2. 03	
"		20	S.C.	10370	Dec. 8. 03	The Cleveland Steel Co.	X	Inventory Jan 1. 04 in Storage.
"		30	S.C.	11170.	Dec. 20. 03	" " "	Dec. 30. 03	
1231		60	S.C.	12128.	Jan 4. 04	The Detroit Steel Cast Co.		

Reserve for Binding.

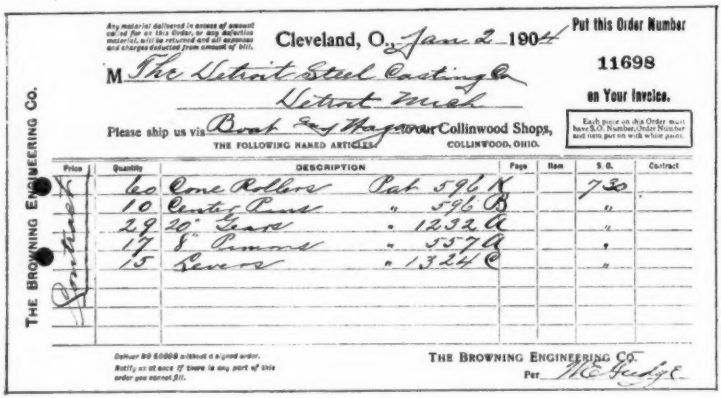
THE PATTERN RECORD.

A record of all patterns is kept by the general stores keeper to assist him in placing orders for castings when they are purchased outside. And transfer or change made by the pattern department is reported on a standard sheet made for the purpose.

Besides the orders which are kept on file until filled, a perpetual shortage list is carried at all times, of material ordered but not received. Copies of these are furnished to the works manager, the purchasing agent, and the outside inspectors of materials.

For convenience all materials purchased are charged to one of

a division of accounts classified as nearly as possible by the department in which it is used. When the delivery is made to some live shop order, the account from which it is delivered is credited with the amount. At the end of each month the total purchased of each kind is added to that on hand at the first of the same month, and the amount delivered subtracted from this total. This gives the value of that remaining, which is recorded on the form shown opposite and is verified by an actual count once a year so that no mistakes nor errors caused by fluctuation of prices may be carried over to the next year. The yearly inventory, which includes not only the stores but every thing of value in the entire plant, is preserved in permanent form as illustrated by the reproduction on page 377.



THE BROWNING ENGINEERING CO.

Any material delivered in excess of amount called for on this Order, or any defective material, will be returned and all expenses and charges deducted from amount of bill.

Cleveland, O., Jan 2 1904

Put this Order Number 11698 on Your Invoice.

Each piece on this Order must have S.O. Number, Order Number and item put on with white paint.

M The Detroit Steel Casting Co. Detroit Mich

Please ship us via Boat Erie Wagon to Collinwood Shops, COLLINWOOD, OHIO.

THE FOLLOWING NAMED ARTICLES

Price	Quantity	DESCRIPTION		Page	Item	S. O.	Contract
	40	Cone Rollers	Pat. 596 K			730	
	10	Centre Pins	" 596 B			"	
	29	20" Gears	" 1232 A			"	
	17	8" Pinions	" 557 A			"	
	15	Levers	" 1324 C			"	

Deliver NO GOODS without a signed order. Notify us at once if there is any part of this order you cannot fill.

THE BROWNING ENGINEERING CO.

Per W E Gudge

PURCHASERS' ORDER.

This order is made out in quadruplicate by the purchasing agent, from the requisition of general stores keeper; two copies remain with him, and are filed numerically and alphabetically; a third copy is sent to the general stores keeper. Original is twice this size, thin white paper.

The material received, after being carefully weighed, counted, measured, inspected, and accepted, is recorded daily on a form for the purpose as shown on page 378. The original is sent to the office to assist in correctly checking and auditing the accounts, while the carbon copy remains with the general stores keeper for reference.

The material that is in stock when the tags are received is at once "reserved" for the order; the material that must be purchased, as soon as it arrives. The proper amounts of the smaller articles, such as nuts, bolts, screws, washers, pipe fittings, etc., after being tied up in a neat bundle by the stock clerks and the tag attached, are placed

Made by S.E.R. **THE BROWNING ENGINEERING CO.** Date Sep-1-1904
CLEVELAND, OHIO.

PERPETUAL INVENTORY.

Month August 1904

S.O.	DESCRIPTION	Inventory	Purchased	Delivered	Inventory	Actual
149	Buildings.	80 20	420 00 70	420 00 70	80 20	
206	Real Estate.		107 00	107 00		
307	Water and Sewer.	27 50	8 10	31 05	4 55	
310	Advertising and Sales.	1205 07	320 19	730 20	795 06	
314	Photography.	20 00	5 20	8 30	16 90	
318	Patents.		2000 00	2000 00		
321	Freight & Transportation.	30 20	870 96	872 70	28 46	
324	Power. Light. Heat & Air.	2750 20	4270 80	5180 72	1840 28	
326	Office	520 15	80 10	60 50	539 75	
435	Culinary.	20 00	15 10	17 20	17 90	
656	Drafting.	350 90	90 71	261 10	418 51	
531	Pattern.	700 70	1076 60	2038 80	692 50	
535	Carpentry	330 25	90 72	80 80	360 17	
652	Stock.	15 20	7 20	8 70	13 70	
725	Tools.	820 30	600 50	520 90	899 90	
728	Electrical	720 50	30 70	92 60	678 60	
730	Machine.	827 70	3240 80	3520 70	7990 80	
734	Machine Fitters.	50 00	2 30	40	51 40	
738	Blacksmiths.	870 92	2606 85	7207 72	4105 85	
741	Structural.	5720 80	4270 90	3210 70	6781 00	
746	Structural Fitters.	72 50	27 01	30 50	69 01	
751	Pipe.	620 90	260 50	178 20	703 20	
756	Paint and Oil.	1270 50	860 50	620 90	1510 10	
760	Erectors.	715 60	20 15	17 20	718 55	
762	Miscellaneous.	2162 83	1210 70	1470 80	1902 73	
	TOTAL	27365 92	22979 29	23913 89	26431 02	

THE PERPETUAL INVENTORY.

This perpetual inventory of crude stock is compiled monthly (or oftener if desirable), from delivery cards, and shows the quantity of each class of material purchased, delivered, and stock on hand.

in one of the bins assigned to the order in the reserved stock room. The castings required are removed from the storage to a reserved space near the machine shop from whence they may be delivered to the machines when these are ready to begin work upon them. In addition to attaching the tag, the shop order number is painted on

Minimum 20
Maximum 60
Measure

THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO.
STOCK CARD.

Description Gear Roller.
Size Pattern 696 K.
Material Steel Casting.

Date Received	Received From	Amount Received	Amount Delivered	Balance	S. O.	Date Delivered	Date Received	Received From	Amount Received	Amount Delivered	Balance	S. O.	Date Delivered
1-7-04	Detroit Steel	60	12	48	1214	1-15-04							
2-1-04	" "	20	40	28	1312	3-4-04							
4-2-04	" "	31	18	41	1419	5-7-04							
8-1-04	" "	23	20	44	1479	6-2-04							

Minimum 50
Maximum 200
Measure

THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO.
STOCK CARD.

Description Valve Bushing
Size $\frac{7}{8}$" I.D.-1$\frac{1}{4}$" O.D.-3" long
Material Soft Steel.
Piece No. 1017.

Date Received	Received From	Amount Received	Amount Delivered	Balance	S. O.	Date Delivered	Date Received	Received From	Amount Received	Amount Delivered	Balance	S. O.	Date Delivered
2-3-04	Shop.	198	20	178	1219	2-10-04							
			18	160	1230	2-20-04							
			30	130	1310	3-17-04							
			60	70	1350	4-1-04							
			1	69	1410	4-20-04							
			10	59	1427	6-1-04							

EXAMPLES OF STOCK CARDS.

These cards are used by the general stores keeper in keeping a record of material. The upper one is filled out as applied to castings, the lower one as applied to manufactured parts in stock.

each casting with white lead, and if possible where it will not be machined off.

The tags for forgings are at once forwarded to the smith shop, which orders suitable stock for the work and makes a report of rough and finished weights of material used when they are delivered

THE BROWNING ENGINEERING CO.
CLEVELAND, O.
INVENTORY RECORD.

Page 6
Date JANUARY 1st, 190 5
Department MACHINE STOCK

S. O.	No. off	DESCRIPTION		List		Discount		Value	
		Amount Brought Forward						$4569	57
		CARRIAGE BOLTS							
	100	¼ x 1½	$1.00 per C.	$1	00				
	86	¼ x 1¾	1.04		89				
	47	¼ x 2	1.08		51				
	65	¼ x 2¼	1.12		73				
	87	¼ x 2½	1.16	1	01				
	32	¼ x 3	1.24		40				
	30	¼ x 3½	1.28		38				
	218	¼ x 4	1.40	3	05				
	174	¼ x 4½	1.48	2	58				
	54	¼ x 5	1.56		84				
	57	¼ x 5½	1.64		93				
	66	¼ x 6	1.72	1	14				
				$13	46	@	75%	$3	36
	126	⅜ x 1½	1.60	2	02				
	119	⅜ x 2	1.76	2	09				
	105	⅜ x 2½	1.92	2	02				
	52	⅜ x 3	2.08	1	08				
	43	⅜ x 4	2.40	1	03				
	75	⅜ x 4½	2.56	1	92				
	61	⅜ x 5	2.72	1	66				
	18	⅜ x 5½	2.88		52				
	45	⅜ x 6	3.04	1	37				
	22	⅜ x 6½	3.20		70				
	35	⅜ x 7	3.36	1	18				
				$15	59	@	75%	$3	89
	96	½ x 1½	3.00	2	88				
	152	½ x 1¾	3.00	4	56				
	116	½ x 2	3.00	3	48				
	4	½ x 2¼	3.00		12				
	58	½ x 2½	3.00	1	74				
	6	½ x 2¾	3.11		19				
	58	½ x 3	3.22	1	87				
	12	½ x 3¼	3.33		40				
	34	½ x 3½	3.44	1	17				
	41	½ x 4	3.66	1	50				
	13	½ x 4½	3.88		50				
	30	½ x 5	4.10	1	23				
	4	½ x 5½	4.32		17				
	59	½ x 6	4.54	2	68				
	5	½ x 7	4.98		25				
	2	½ x 7½	5.20		10				
	89	½ x 8	5.42	4	82				
	35	½ x 9	5.86	2	05				
				$29	71	@	75%	$7	42
		Forward						$4584	24

THE YEARLY INVENTORY.

This inventory is taken once a year by actual count and is valued at the market price January 1. This is used as a basis from which the perpetual inventory is derived.

to the next department. The material for the small duplicate work is delivered with the tags and cards direct to the screw machines, and the finished product, after being inspected, is returned to the reserve stock bins to await assembling.

The rough and drawn shafting is all cut to proper length with the ends centered and chamfered where required and delivered to

THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO
Report No. 3296

RECEIVING CLERK'S DAILY REPORT FOR Jan 12 1905

Reserve for Binding.	No. Rec'd	DESCRIPTION	Buyer's Order No.	Con. No.	S. O. No.	Page	Item	Total Weight
		The Strong Carlisle & Hammond Co						
	12	1/2" S.S. Drills	12005		725			
	1	Bale XX Waste	11920		"			500
	1	Dz 12" Mill Cut Files	12120		"			
	1	1/2" Diam Brass Rod	"		730			1
		The Fulton Foundry Co						
	12	12" Wheels Pat 19208	12120		730			1200
	27	Std Caps " 7607	"		"			270
	15	Bases " 5706	12131		"			1050
	15	Bridges " 5705	12120		"			150
		The Bourne Fuller Co						
	12	Obstacles 3/8 x 12'-0"	11190		741			5040
	10	" 2 1/4 x 1/4 x 20'-0"	"		"			4080
	5	Angles 2" x 2" x 1/4 x 17'-0"	"		"			272
	12	" 5" x 5" x 1/2 x 20'-0"	"		"			5532
	2	Channel 6" x 8" x 17'-0"	"		"			272

Signed W. E. Hardy

RECEIVING CLERK'S DAILY REPORT.

This report is made out daily by the general stores keeper, showing the material received, from whom received, number, size, weight, etc., so that all invoices may be intelligently checked by the auditing and cost departments.

the machine or fitting departments with tag attached. To further identify it, the shop order and sheet number is stamped on the end of each piece. All of the pipe is cut to suit the fittings by the operator of the cutting-off machines and placed in the reserve stock room with tags attached. The rivets are counted out and reserved in kegs for

CARD No. 7293 — THE BROWNING ENGINEERING CO. — CON. NO. 173

CLEVELAND, OHIO. — S. O. 1317

From Paint Dep't. — DELIVERY CARD — Date September 1904

Description of Material	Quantity	Weight	Price	Cost	Description of Material	Quantity	Weight	Price	Cost
Linseed Oil					Alcohol (Wood)				
Engine Oil					Coal Oil				
Cylinder Oil	1gal.				Gasoline				
Machine Oil	1gal.				Benzine				
Screw Cutting Oil					Turpentine				
Sperm Oil					Enamel				
Black Oil					Surfacine				
					Water Color				
					Asphaltum				
Mixed Paint					Roofing Cement				
Varnish					White Lead				
Shellac (White)					Yellow Ochre				
Shellac (Orange)					Cup Grease		2 "		
Machinery Paint	8gals.				Putty				
Machinery Filler		20 "			Structural Red	2 gals.			
Wood Filler					Venitian Red				
					Lamp Black				

Signed Christie.

CARD No. 10185 — THE BROWNING ENGINEERING CO. — CON. No. Clerk Stock

CLEVELAND, OHIO. — S. O. 1219

From Stock Dep't. — DELIVERY CARD. — Date Aug. 1904

CH'K	No. PIECES	DESCRIPTION	MAT'L	SIZE OR PATTERN NO.	LENGTH Feet	LENGTH In.	FROM S. O. No.	SHEET No.	BILL OF MAT'L Page	BILL OF MAT'L Item	PRICE	WEIGHT	AMOUNT
8-11	72	Cap Screws.	S.S.	5/8"		1 1/2	730	1385	1	7			
8-11	72	Lock Washers.	S.S.	5/8"			730	"	1	8			
8-11	8	Grease Cups.	"	#8			762	"	1	9			
8-11	24	Dowel Pins.	Bz.	1/4"		1/2"	1017	"	1	3			
8-20	12	Bushings.	Bz.	850 C.			730	"	1	2		1 20	
8-25	2	Helix. R.H.	S.S.	9" diam		4"			1	4		6 50	
8-25	12	Helix. L.H.	S.S.	9" diam		6"			1	5		8 00	

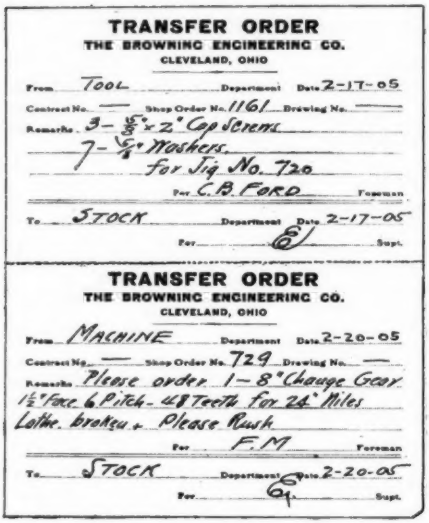
Signed W. E. Fudge.

SPECIMENS OF DELIVERY CARDS.

These cards are made by the general stores keeper and show the exact material used, which may or may not agree with the bill of material. They are delivered to cost-keeping department at end of each month.

the structural department, a certain amount being allowed for shrinkage caused by burnt or badly driven ones.

No material is delivered or reserved unless the full amount called for by the tag is on hand, and when it is delivered, entries are made in the general stores keepers bill of material, of the date, depart-



TRANSFER ORDER
THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO

From TOOL Department Date 2-17-05
Contract No. — Shop Order No. 1161 Drawing No. —
Remarks 3- 5/8" x 2" Cap Screws
7- 1/4" Washers.
For Jig No. 720
Per C.B. FORD Foreman
To STOCK Department Date 2-17-05
Per E Supt.

TRANSFER ORDER
THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO

From MACHINE Department Date 2-20-05
Contract No. — Shop Order No. 729 Drawing No. —
Remarks Please order 1-8" Change Gear
1½" Face 6 Pitch - 48 Teeth for 24" Niles
Lathe. broken + Please Rush
Per F.M Foreman
To STOCK Department Date 2-20-05
Per G Supt.

TRANSFER ORDERS.

Used by all departments for getting stores not called for on the bill of material. A carbon copy is made and retained by the issuer of the order. Double this size, thin blue paper.

ment, and the number of the delivery card upon which the material is charged. Then the follow cards are forwarded to the foreman of departments where the material was delivered, and his bills of material dated. The material in the reserve stock room may be obtained at any time by any department upon presentation of their bills of material to be stamped by the stock clerk when the material is delivered. All orders for material built on stock, repairs, or direct for a customer follow the same general course.

In any system exceptions are sure to arise which it is practically impossible to whip into line. To meet these contingencies a tranfer order was devised as shown in accompanying cut. Each foreman carries a small book of these orders with him at all times, and all requisitions for repairs, replacements, new tools, exchanges, etc., are written by him and the original sent to the superintendent's office for authorization; the carbon copy remains in the book. The original is never accepted unless it bears the superintendent's signature. All material for new tools and work done on them in other departments are procured by means of these orders.

While there are innumerable little kinks and curls which intertwine themselves with the daily working of the system, it remains in the main as here set forth; and while conditions are continually causing minor changes, it has been found to meet most admirably the general requirements for which is was created.

UTILIZING THE POWER OF THE NIAGARA RAPIDS.

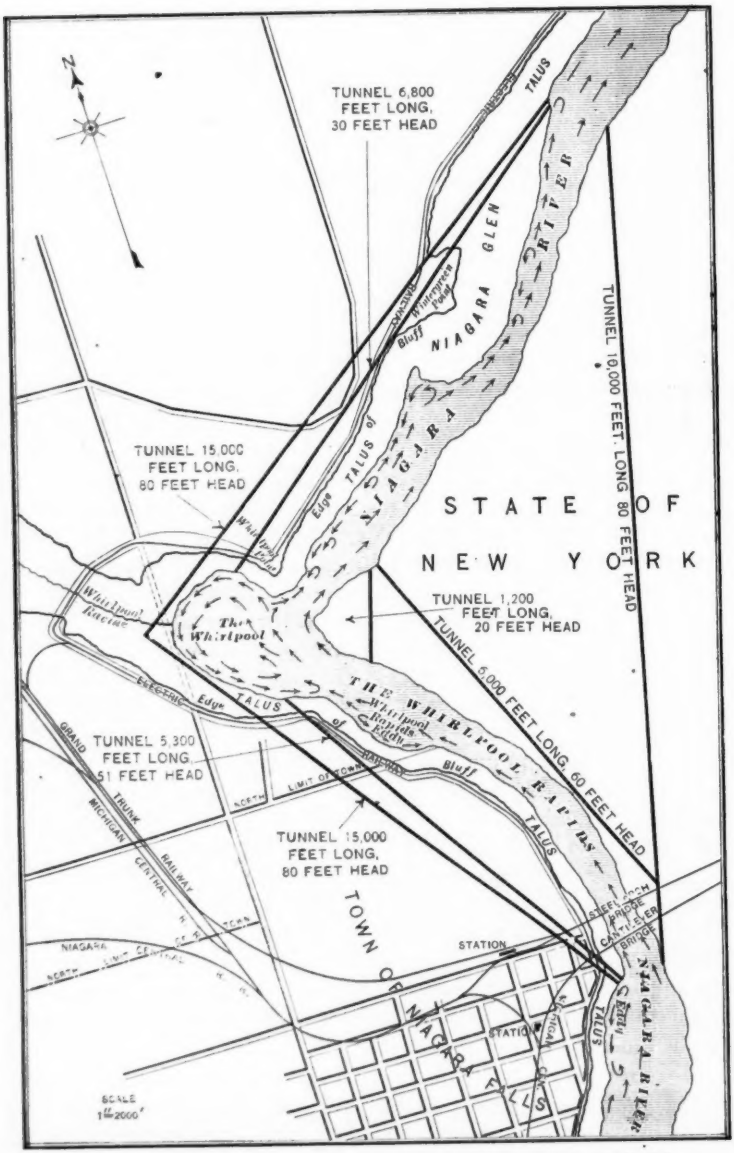
By Alton D. Adams.

Recent events have directed attention again to the heavy demands which are being made on Niagara Falls for power uses, and the menace of their serious impairment as a scenic feature. This is a possibility which none but a very few ultra-utilitarians would care to contemplate. Mr. Adams' paper is therefore of much interest in that it proposes a way by which the probably inevitable continuance of the power demands may be fully met with a minimum of loss to the natural beauty of the region.—THE EDITORS.

THE Niagara River descends 100 feet and develops 2,500,000 horse power between the base of the great cataract and the foot of the escarpment at Lewiston and Queenston, five miles down stream.

This energy, represented by the normal discharge of 222,000 cubic feet of water per second, is now expended in excavating the great gorge in which the White Horse Rapids, the Whirlpool, and Niagara Glen are located. Fully 80 feet of this fall along the rapids occurs between a point several hundred feet south of the Cantilever Bridge and another at the lower end of the glen, which can be connected by a tunnel some 10,000 feet long, on the New York side of the river. With the head of 80 feet and the discharge of 222,000 cubic feet per second, named above, these rapids thus develop 2,000,000 horse power, as mechanical motion and heat. This power is fully one-half as great as that of the American and Horse Shoe Falls combined, since the volume of water is substantially the same in the falls and the rapids, and the descent of the former is only twice that of the latter. Making the fair assumption that 60 per cent. of the gross energy in the water of these rapids can be transformed into electric current, the output of plants utilizing the entire flow would reach 1,200,000 horse power. This capacity is nearly double that of the six great electric power stations that are now in various stages of completion about Niagara Falls, three on the New York and three on the Canadian side of the river.

No great difficulty in the way of engineering appears to exist as to the development of the power of the rapids in the Niagara Gorge, either by means of tunnels or of a dam. The rock formation about the gorge is much like that at the falls, and the river just above



MAP OF THE NIAGARA RAPIDS AND THE POSSIBLE POWER TUNNELS.

Lewiston, where a dam might be located, flows between perpendicular walls of rock that are less than 1,000 feet apart.

If advantage is to be taken of the steeper parts of the rapids, both above and below the whirlpool, so as to obtain an operating head of not less than 80 feet of water by a tunnel, the intake end of the tunnel on the New York side of the Niagara River should be located beneath the water level at a point some 400 feet above the Cantilever Bridge, and the lower end should discharge into the gorge about 7,000 feet down stream from the whirlpool. A tunnel in a straight line between the openings just named would represent one side of a triangle, with the chains of rapids above and below the whirlpool respectively for the other two sides.

With the tunnel just suggested, the generating station might be located over a wheel pit at the intake end, as is the case with some of the existing plants, or at the discharge end in the gorge. In this latter case it might be desirable to lay a steel pipe line in the tunnel so that no forebay would be necessary at the lower end. The length of this tunnel, 10,000 feet, is not great enough to create an unduly large investment, and it is in fact only 2,564 feet longer than that which carries the tail water from the two largest plants on the New York side of the falls. As the head of water made available by this tunnel is only one-half of the height of the American Falls, the cross section of the proposed tunnel would probably be about twice as great per horse power of capacity as is the area in cross section of the existing tunnel of the Niagara Falls Power Company. This tunnel is 21 feet high, 18 feet 10 inches wide, and delivers the tail water from two generating stations that have a combined capacity of 105,000 electric horse power. As one of these stations utilizes only 136 feet of water head at its wheels, owing to the lack of draft tubes, the power capacity of this existing tunnel would be greater if the wheels that discharge into it operated under the full head afforded by the American Fall. Any disadvantage in the matter of first cost per horse power of capacity in the proposed tunnel along the rapids, due to the fact that the head thus made available would be limited to about 80 feet, is fully offset by the great cross-section and capacity that may be given to this tunnel. Each of the three great power tunnels that now pierce the cliffs about Niagara Falls has been limited in its capacity to correspond more or less nearly with the water rights of the company that built it. Thus the tunnel of the Niagara Falls Power Company is designed for a development of about 100,000, the tunnel of the Canadian Niagara Power Com-

pany for a development of about 110,000, and the tunnel of the Toronto Niagara Power Company for a development of about 117,000 horse power in electric generators. With sufficient water to develop 1,200,000 electric horse power under a head of 80 feet going down the rapids, there need be no such limitation as the figures just given on the capacity of a tunnel from the upper to the lower gorge. Such a tunnel might, in fact, be designed to suck down one-half the entire discharge of the river, and to deliver water for a power development that would equal the combined capacity of the six great hydro-electric plants now completed or under construction on both sides of the falls. A very large tunnel like that just suggested would cost less per horse power of capacity than have some of the smaller existing tunnels. Looking at a map of the Niagara River below the falls, it may be seen that the tunnel just suggested is shorter than any other tunnel or combination of tunnels that can be devised to render available an equal head of water in the rapids above and below the whirlpool. This is due to the alignments of the two main series of rapids, which are at right angles with each other, and have the whirlpool at the apex. Because of this formation of the river bed, New York State offers a more favorable site than Ontario for the transformation of the power of the rapids into electric energy. To obtain the same head of water on the Ontario side of the river, by a tunnel opening about 400 feet up stream from the Cantilever Bridge, and about 7,000 feet down stream from the whirlpool, the tunnel must pass the whirlpool by a change of about 90 degrees in direction, and have a length of about 15,000 feet, or 50 per cent. more than the length of a tunnel to develop a water power of equal head on the New York side.

While the power development just considered, with a tunnel whose intake is above the rapids and whose outlet is below, in the gorge, is more attractive than any other that is practicable on the lower river, because it offers the greatest head for anything like the same length of tunnel, it is by no means the only possible one there. In fact, there are numerous locations, both above and below the whirlpool, where hundreds of thousands of horse power may be developed under heads of 20 to 60 feet, with only moderate investments in plant construction. On the New York side of the river the great promontory of limestone and shale, that separates the rapids above from those below the whirlpool, might be pierced by an indefinite number of tunnels that would give heads of water roughly proportionate to their lengths.

One such tunnel piercing the promontory a few hundred feet back from its point at the whirlpool, and about 1,200 feet long, would develop a water head of about 20 feet. From a point 400 feet above the Cantilever Bridge, to the brink of the river 1,000 feet below the point of the New York promontory, the length of a tunnel substantially parallel with the whirlpool rapids would be about 6,000 feet, and this tunnel would maintain a water head of fully 60 feet.

Passing to the Ontario side of the river, where the utilization of the entire head of the rapids both above and below the whirlpool would require a rather long tunnel, it appears that several developments of lesser heads may be made with only moderate investments. For one of these the intake end of the tunnel would be located about 400 feet up stream from the Cantilever Bridge, and its vent would be at the upper side of the whirlpool, so that a head of about 51 feet would be obtained with a tunnel length of approximately 5,000 feet. This is one of the best sites for power development under moderate head in the gorge, and can be nearly duplicated on the opposite New York bank. The necessity for a tunnel instead of a canal in all of these cases is due to the fact that the perpendicular cliffs on either side of Niagara Gorge rise to a height of 200 feet or more above the water, so that an open canal is impracticable. From the lower side of the whirlpool, and beneath that part of the gorge known as Niagara Glen, where the distance between the high cliffs increases to several times the width of the river, and leaves a wide bench of talus next to the stream on the Canadian side, a tunnel 6,800 feet long will develop a water head of about 30 feet. In this case again a tunnel of about the length just named, running down stream from the whirlpool on the New York side of the river, would develop a head equal to that which could be maintained by a parallel tunnel on the Canadian side.

Each of the proposed developments of water power under heads of 20 to 60 feet, as named above, can be carried out at a moderate investment per horse power of capacity, but this cost per unit of capacity would necessarily be somewhat greater at each of the heads under 60 feet than under the head of at least 80 feet that might be developed by a 10,000 foot tunnel across the New York promontory. These tunnel developments do not, however, exhaust the possibilities of water-power plants in Niagara Gorge.

Dam Niagara, drown the White Horse Rapids, fill up the whirlpool, raise the water level in the gorge 100 feet, change the river into a storage reservoir from the foot of the cataract to the brow of the

escarpment, and 1,500,000 electric horse power may be developed at Lewiston. When this power is not in use a third cataract will be created, with the combined discharge of both the American and the Horse Shoe Falls flowing over a dam 100 feet high between Lewiston and Queenston. At this dam fully 60 per cent. of the energy of 222,000 cubic feet of water per second falling 100 feet and developing 2,500,000 horse power may be transformed into electric current. If the question of power development at the escarpment was the only one to be considered, the dam at Lewiston might be 200 feet high without overflowing the sides of the gorge; but such a dam would raise the water basin at the foot of the American and Horse Shoe Falls 100 feet, thereby destroying these falls in a large degree, and also the value of the great generating stations that draw water from the upper river. A dam about 100 feet high, corresponding to the drop of the river surface from the foot of Niagara Falls to Lewiston, 5 miles below, would work no substantial injury either to the natural falls or the existing power plants.

On the other hand, the 100-foot dam at the brow of the escarpment would flood the rapids, and turn the whirlpool into a comparatively quiet body of water. As an offset to the loss of these scenic advantages, the proposed dam across the river just above Lewiston would develop a great power at a much lower cost per unit than can be effected with tunnels between different points in the gorge. The 1,500,000 horse power that might be developed by means of a dam 100 feet high at Lewiston is more than twice the capacity of all the hydro-electric plants now completed or in process of construction about Niagara Falls. As only a small fraction of the ultimate combined capacity of these plants is at present utilized, it seems that the additional development of 1,500,000 horse power at Lewiston, thus raising the total from Niagara River to more than 2,000,000 horse power, would provide all the energy that could be utilized within 300 miles of the falls in at least the next half-century.

The prospect of cheap electric energy is not only the inducement to the development of the above water powers in the gorge, either by means of tunnels through the cliffs or of a dam at Lewiston. A result of these developments on the lower river might well be to save from destruction that portion of the American Fall that has not already been granted away for power purposes. The demand for water rights at Niagara Falls is pressing hard for authority to dry up the American cataract, and Canada has taken advantge of the situation by leasing franchises that will yield more than $300,000

annually as water rent. Plants now partly completed on the Ontario side of the falls have the right to draw 32,000 cubic feet of water per second from the upper river, and an allowance of 3,000 feet per second for the Welland Canal raises the total there to 35,000 cubic feet per second. On the New York side of the falls, power plants completed or under construction have the right to suck down another 32,000 cubic feet of water per second, and this must be increased by 6,000 cubic feet for the Chicago Drainage Canal, and 1,200 cubic feet for the New York barge canal, a total in the United States of 39,200 cubic feet of water per second from the Great Lakes above the falls. The combined capacity of works already authorized on both sides of the lakes and river is thus not less than 74,200 cubic feet of water per second. This volume of water is 33 per cent. of the normal and 45 per cent. of the minimum discharge of Niagara River, and if its diversion above the falls does not entirely dry up the American cataract, this result will certainly be accomplished by a few more large grants.

In considering the effect of the diversion of water from the upper river on the American and Horse Shoe Falls, it should be remembered that the channel leading to the former, owing to its greater elevation and less width, carries only 10 to 20 per cent. of the total river discharge. As a result, a reduction of a very few feet in the river level above Goat Island will lay bare the channel to the American Falls, while the Horse Shoe Falls still carry a large volume of water. If diversion of water above the falls was the only practicable method of developing Niagara power, it might be very hard for New York to check the ardor of investors, or for the Government of Ontario to deny itself further income from the lease of water rights. While it is entirely practicable, however, to develop some 1,500,000 electric horse power in the gorge, there seems to be lacking any good excuse for the complete destruction of the American Falls. Nor is this conclusion shaken by the probability that the development of power sites in the gorge will be somewhat more expensive per unit than that of plants close to the falls. Those who have enjoyed the wild scenery of the White Horse Rapids at close range will be loth to give them up, but when the hard alternative is to drown these rapids or dry up the American Falls, the former seems much the less of the two evils.

THE EFFECTS OF VACUUM ON STEAM-ENGINE ECONOMY.

By R. M. Neilson.

Mr. Neilson's first two articles in the current series dealt with the use of superheated steam. His third, in our issue for May, discussed the general aspects of the economy of condensing. The present paper reviews the principal types of condensing apparatus and their operation. A concluding section will take up cooling towers and give further attention to air and circulating pumps and other auxiliaries.—THE EDITORS.

A NON-CONDENSING engine is often converted into a condensing one, not for the sake of economy, but in order to obtain a greater power without the installation of a fresh engine and a fresh boiler. Greater efficiency should be obtained in every case, but whether there will be any commercial gain depends upon the circumstances of the case.

The financial advantage to be obtained by condensing depends, of course, on the nature and cost of the water obtainable, which involves the question of the most suitable type of condensing plant. If the water obtainable for condensing purposes is suitable for use as boiler feed water, and if the price of this water does not prohibit its being used in considerable quantities, it is usually advisable to employ a jet condenser. It may also be advisable to use a jet condenser in the very opposite case—namely, when the water is extremely bad and would cause a deposit on the tubes of a surface condenser such as would much impair the efficiency of the condenser unless this were very frequently cleaned. In such a case it is usually best to employ a jet condenser (or an ejector condenser) and use fresh water for the boiler feed instead of drawing this from the hot well. A limited supply of pure water suitable for boiler feed is usually obtainable, although it may be too expensive to use for condensing purposes with a jet, ejector, or surface condenser. Compared with surface condensers, jet condensers are cheap and simple and do not readily get out of order; and if the counter-current system (to be described hereafter) is adopted, they are very effective in obtaining a high vacuum.

It is of course desirable with any condenser to have the condensing water as cold as possible, as then a given weight of it has a greater cooling effect; and it is easier to get the heat of the steam

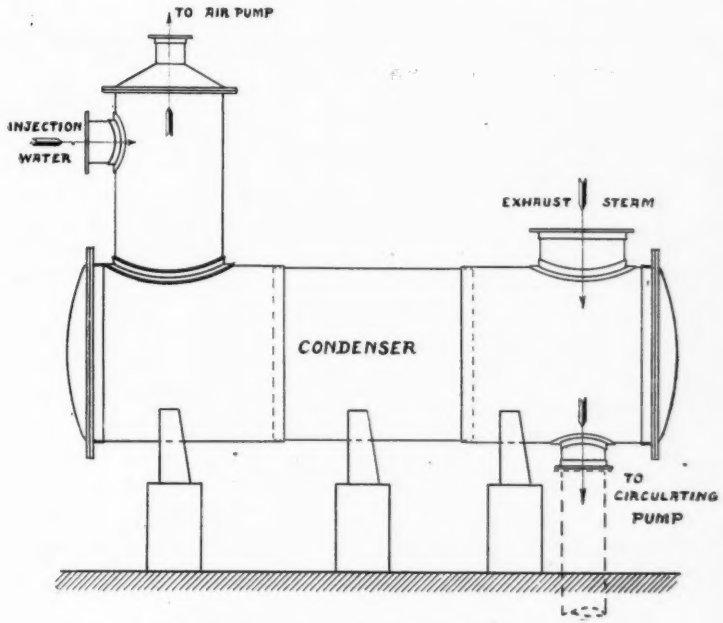
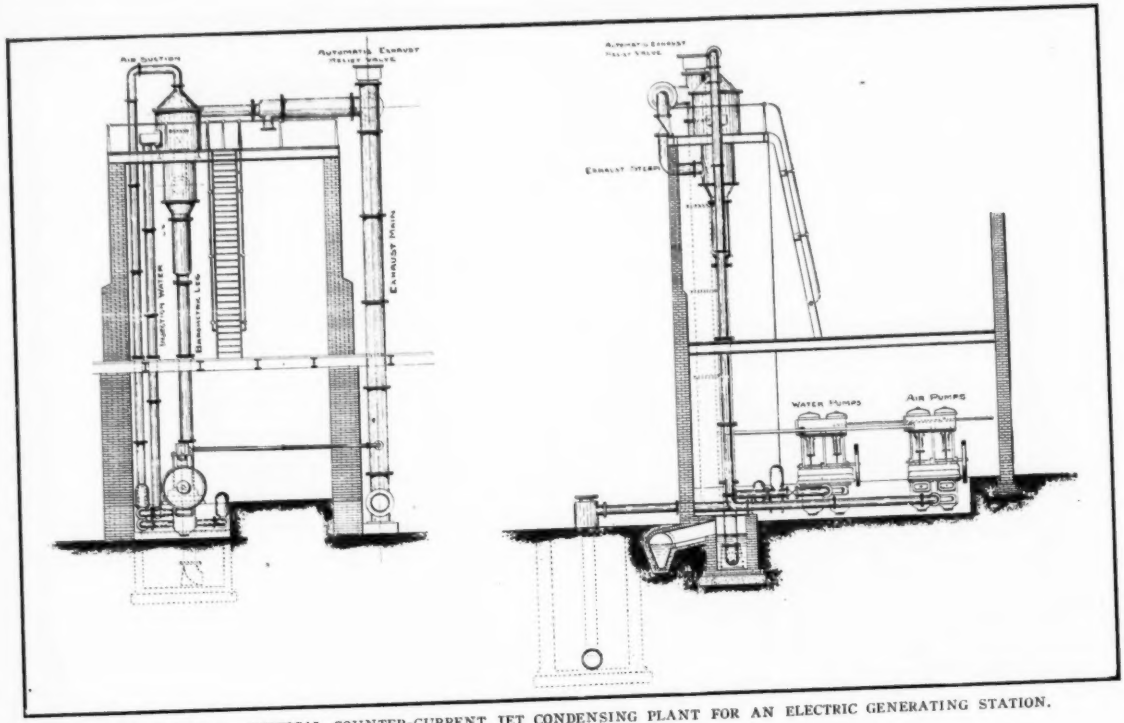


FIG. 1. HORIZONTAL COUNTER-CURRENT JET CONDENSER.
Klein Engineering Co., Ltd., Manchester.

(and air) transferred to the cooling water when there is a considerable difference of temperature between these than when there is only a slight difference. If very cold condensing water cannot be obtained, and if condensing water has to be used which is at a temperature very near to the required temperature of the steam and condensed water in the condenser to give the desired amount of vacuum, a jet condenser of the counter-current type is much to be preferred to a surface condenser of any type. In a jet condenser the cooling water mixes with the steam and air and can directly acquire heat from them, whereas in a surface condenser the heat has to be transferred through metal.

A standard design of horizontal counter-current jet condenser as made by the Klein Engineering Company, Ltd., of Manchester, is shown in Figure 1. The exhaust steam enters at one end of the condenser and the air contained in the steam is drawn the full length of the condenser and makes its exit along with the (cold) air which enters with the injection water, just above the place where the water



FIGS. 2 AND 3. VERTICAL COUNTER-CURRENT JET CONDENSING PLANT FOR AN ELECTRIC GENERATING STATION.
Klein Engineering Co., Ltd., Manchester.

enters. The injection water along with the condensed steam leaves the condenser just below the place where the steam enters.

This counter-current arrangement allows of the air leaving at the lowest possible temperature and therefore with the lowest possible volume. This is an important consideration as regards the necessary capacity of the air pump. The counter-current arrangement also gives the water the opportunity of acquiring as much heat as possible. It is desirable that this should be so in order to provide feed water at as high a temperature as possible, and in order that as small a quantity of injection water as possible may be used. The reduction in the amount of injection water used is important even if the water is obtained for nothing, as it not only reduces the necessary capacity of the water pump or pumps, but it also reduces the necessary capacity of the air pump, because the more injection water used, the more air will come in with it and have to be removed by the air pump. In a condenser of this nature it is usual, as the air and water leave the condenser separately, to employ separate pumps for withdrawing them—namely, a dry air pump (which is almost invariably of the reciprocating type) and a water pump, which is usually reciprocating but not infrequently rotary.

Figures 2 and 3 illustrate a counter-current vertical barometric jet condenser and pumps supplied by the Klein Engineering Company, Ltd., to a corporation electricity works. The plant is of a capacity of about 1,500 horse power and deals with the exhaust steam from high-speed reciprocating engines. River water is employed for condensing, and a vacuum of 27 to 28 inches of mercury is obtained. Twin air pumps are employed which are driven by a compound steam engine. The injection water is supplied by a similarly driven pair of water pumps. It will be seen that the injection water enters the condenser near the top and that the air is withdrawn at the very top, where it will be coolest and densest. The exhaust steam, as seen in Figure 3, enters well below the injection water.

The condenser is situated at a height above the ground nearly as great as if not greater than the height of a water barometer (hence the term "barometric condenser") so that the condensing water and the water of condensation will discharge themselves by gravity in spite of the vacuum in the condenser.

A condenser of the barometric type has the advantage that no pump is required to draw off the water. When a high vacuum is desired at the engine the barometric condenser has the objection of the long exhaust-steam pipe.

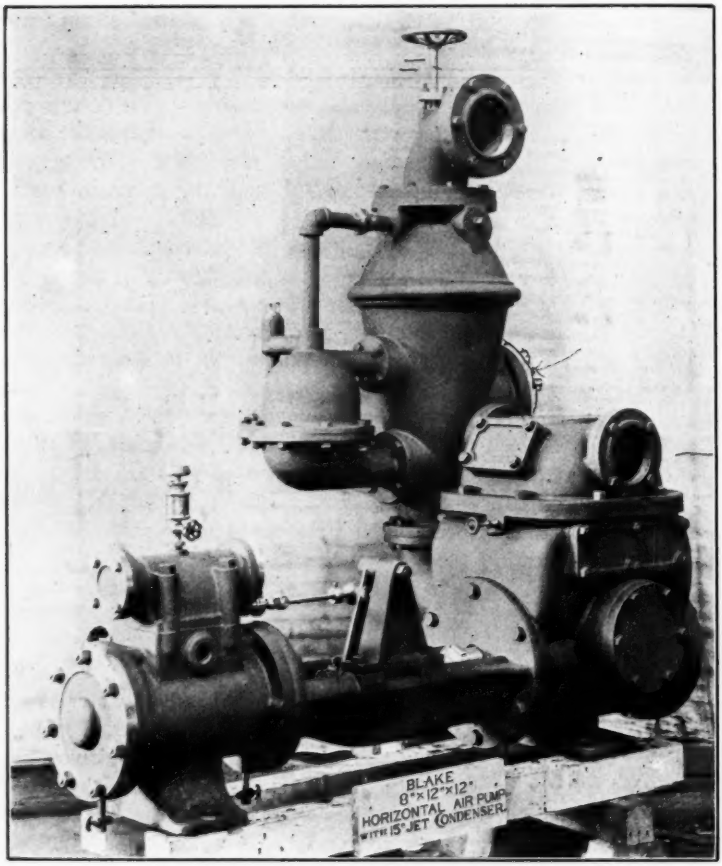


FIG. 4. BLAKE JET CONDENSER AND AIR PUMP.

Made in sizes capable of dealing with from 1,600 to 26,000 lb. of steam per hour, with condensing water not over 70° F. Built by International Steam Pump Co., New York.

Although the counter-current arrangement of jet condenser is very advantageous, parallel-current jet condensers are very commonly employed, the exhaust steam and the injection water entering at one end, usually the top, and the water and air being withdrawn together at the other end by the same pump or pumps. An example of such a construction is shown in Figure 17, the triple-throw pump being seen behind the condenser.

If the water is unsuitable for use in boilers in the state in which it is obtained, we cannot draw our feed water from the hot well and at the same time use condensers in which the condensing water is mixed with the condensed steam. The condensers in such cases must be of the surface type, and to make up the losses in the boiler feed we must supplement the water obtained from the hot well by purifying some of the supply (impure) water or purchasing some relatively expensive pure water.

Figure 7 shows a 6,000-indicated-horse-power surface condenser constructed for the Manchester Corporation Electricity works by Messrs. Mather and Platt, Ltd., of Manchester. The body and end covers are of cast iron. The tubes are of brass, and the tube plates

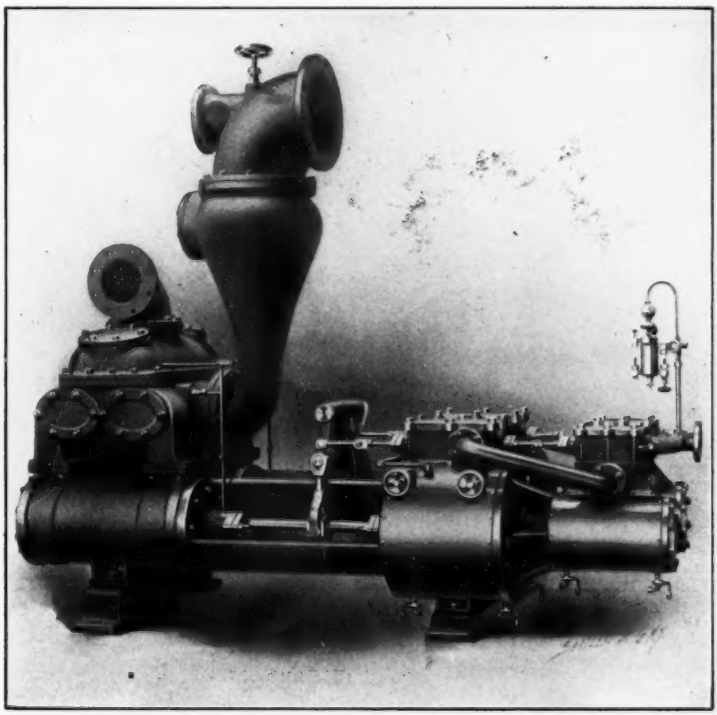


FIG. 5. WORTHINGTON AIR PUMP AND JET CONDENSER WITH COMPOUND STEAM CYLINDERS.

Suitable especially for large plants where the feed water is heated by economizers or exhaust steam. The cost of producing vacuum is minimized. Built in sizes from 1,000 to 10,000 horse power. International Steam Pump Co., New York.

are also of brass, the tubes being secured to the tube plates by brass ferrules. The circulating water, as is usual, passes through the tubes, the exhaust steam being on the outside of the tubes.

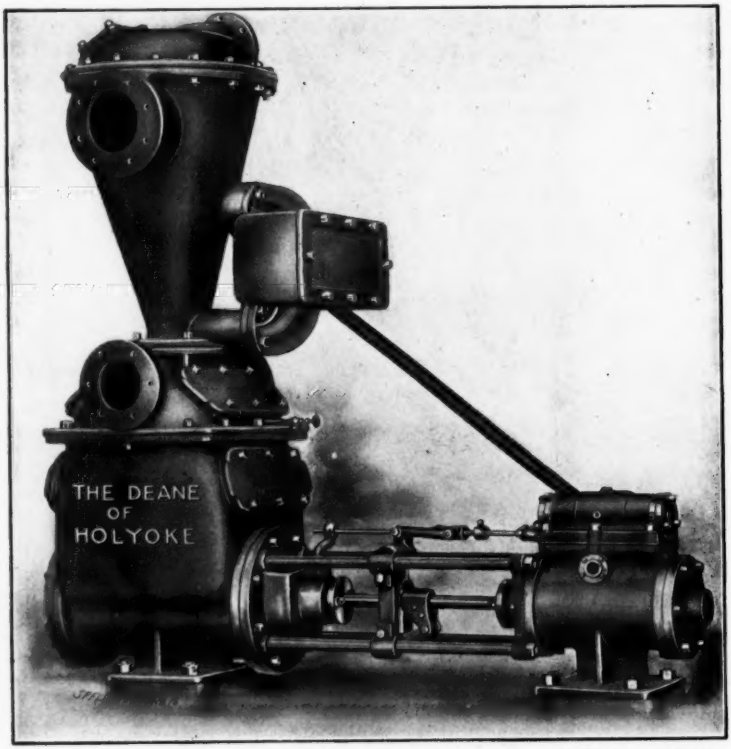


FIG. 6. DEANE JET CONDENSER, WITH SINGLE DIRECT-ACTING HORIZONTAL VACUUM PUMP.
International Steam Pump Co., New York.

Figure 8 shows a surface condenser with air and circulating pumps constructed by the Mirrlees Watson Company, Ltd., of Glasgow, and installed at the Northampton Electricity Station. The plant is designed to deal with 12,000 pounds of exhaust steam per hour and to give a 26-inch vacuum. The twin air pump seen in the front is of the Edwards type and is driven through single reduction gearing by the electric motor on the right. The two adjacent crank-shaft-supporting brackets of this pump are bolted together at the top and carry a common pair of long brasses and a common long

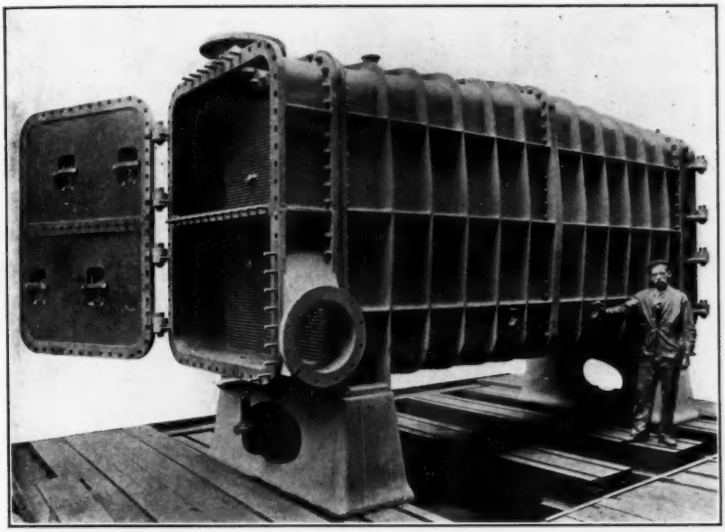


FIG. 7. A 6,000-HORSE-POWER SURFACE CONDENSER FOR THE MANCHESTER CORPORATION ELECTRICITY WORKS.
Mather & Platt, Ltd., Manchester.

cap. The centrifugal pump seen direct-coupled to the electric motor on the left is for circulating the cooling water through the condenser tubes. The surface condenser is seen at the back. It is of cast iron with brass tubes and tube plates and ferrules.

Figure 9 illustrates a surface-condensing plant constructed by the Mirrlees Watson Company, Ltd., to work in connection with

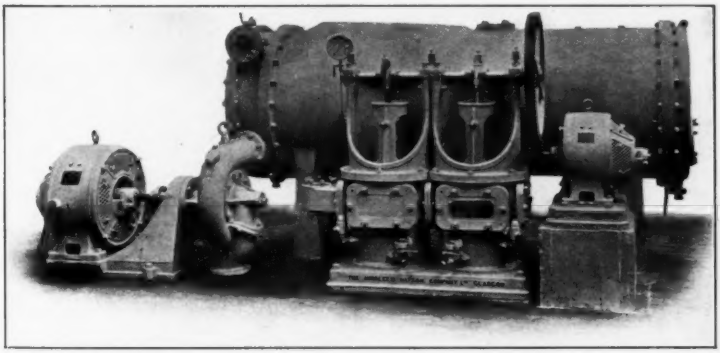


FIG. 8. SURFACE CONDENSER WITH MOTOR-DRIVEN AIR AND CIRCULATING PUMPS.

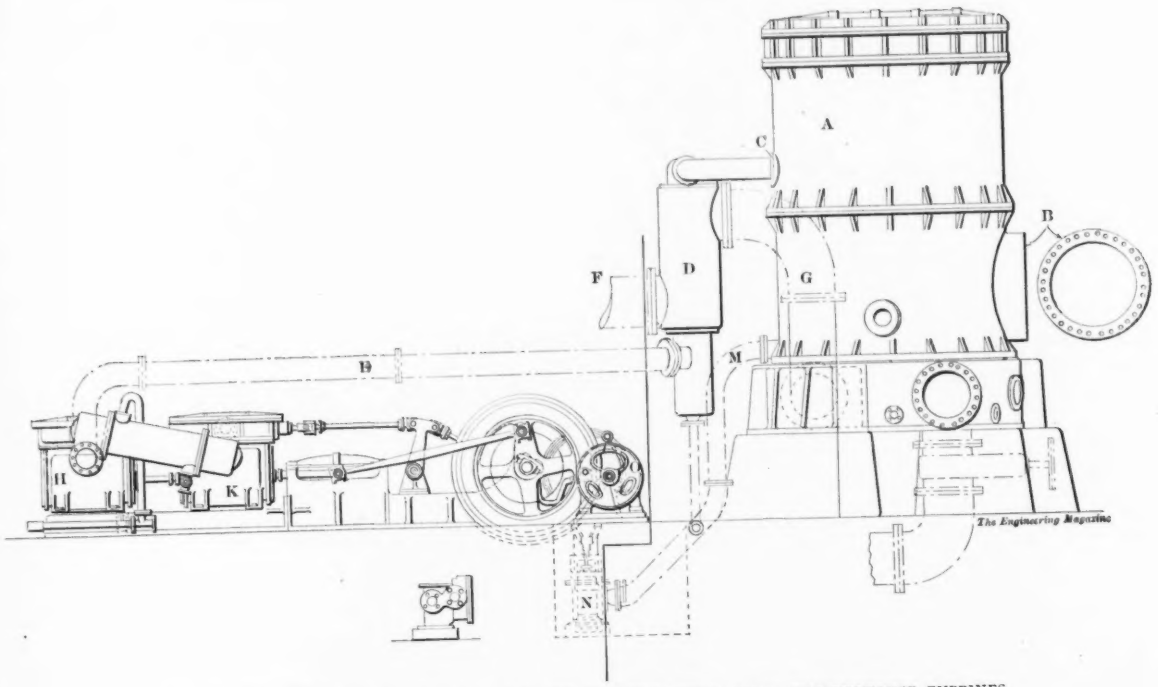


FIG. 9. SURFACE CONDENSING PLANT FOR USE IN CONNECTION WITH WESTINGHOUSE TURBINES.

the Westinghouse turbines for India. There are two surface condensers, each arranged with its own pumps and each designed to deal with 26,250 pounds of exhaust steam per hour at normal load and to maintain a vacuum of 27½ inches of mercury (with the barometer at 30) when using cooling water at 87 degrees F. Each set is also expected to be able to deal with 40,000 pounds of steam at overload and with this quantity of steam to maintain a vacuum of at least 26 inches. Only one set is here shown.

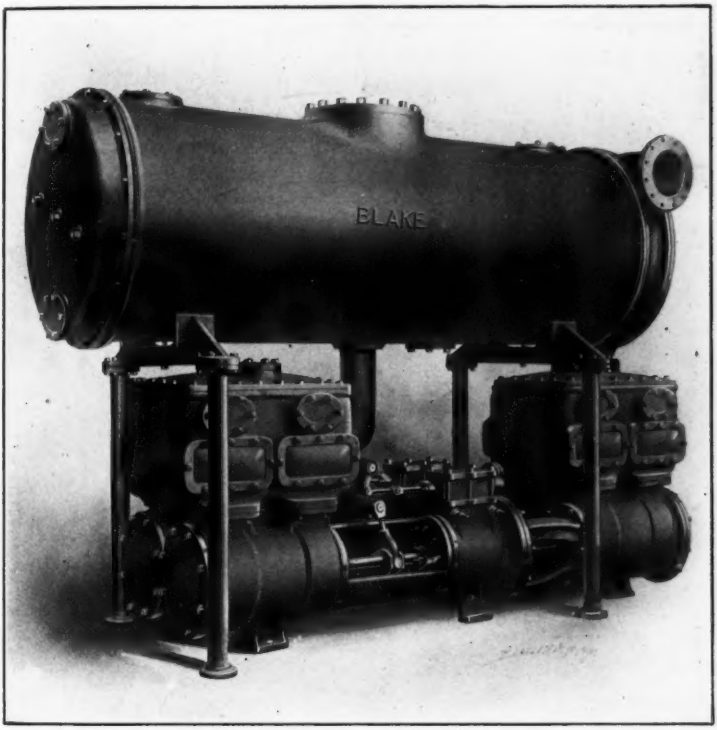


FIG. 10. SURFACE CONDENSER WITH AIR AND CIRCULATING PUMP.
Cast-iron shell, with baffle plate to distribute exhaust steam seamless drawn brass tubes, with ends passing through adjustable glands permitting free expansion and contraction. International Steam Pump Co., N. Y.

A is the surface condenser, which is of the vertical type and is constructed of cast iron. The exhaust steam enters the condenser through port B, which is 36 inches in diameter, and passes four times the full length of the condenser. The air is withdrawn from the

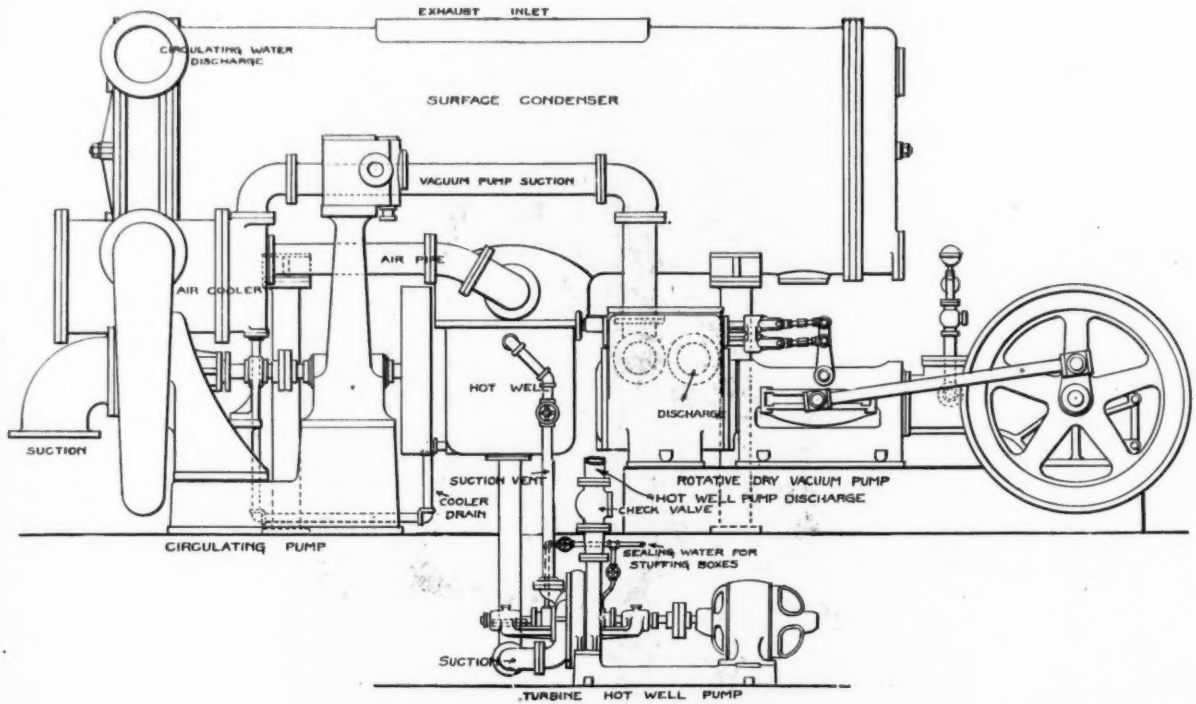


FIG. 11. WORTHINGTON CONDENSING APPARATUS FOR STEAM TURBINES.
International Steam Pump Co., New York.

condenser at C and is sucked through tubes in the vessel D, leaving this vessel and passing to the dry air pump by the pipe E. The circulating cooling water approaches the condenser by the way of the pipe F. It passes through the vessel D around the air tubes and then proceeds by way of the pipe G to the condenser, which it enters at the bottom. Division plates are arranged in the condenser so as to cause the water to pass four times the full length of the condenser in the opposite direction to the steam, thus producing a counter-current arrangement. The condenser has 5,880 square feet of cooling surface. The tubes are of solid drawn brass 1-inch external diameter and 18 S. W. G. thick.

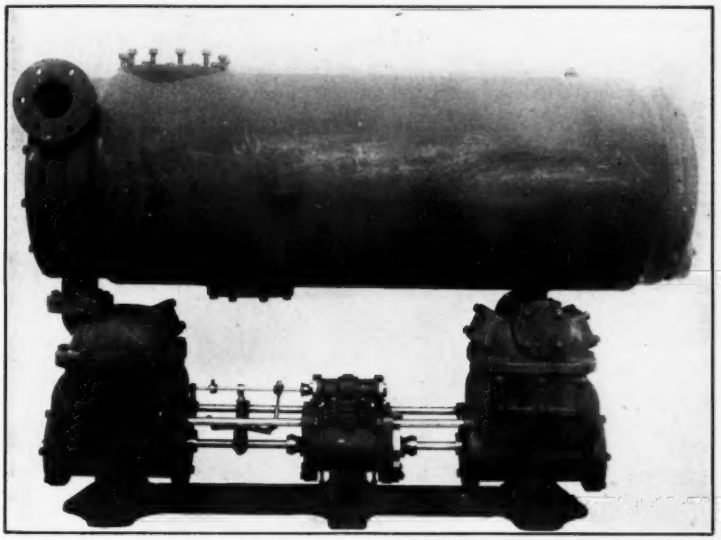


FIG. 12. KNOWLES COMBINED AIR AND CIRCULATING PUMP WITH SURFACE CONDENSER OF 400-SQUARE-FEET SURFACE.
International Steam Pump Co., New York.

A two-stage horizontal air pump is employed. The two cylinders H and K are arranged tandem on the same bed plate. They are each 17 inches in diameter and have each a stroke of 24 inches. The air pump deals only with air and vapor, the water of condensation being drawn off from the condenser along the pipe M, (where it is joined by the water separated from the air in the vessel D) by the small double-acting plunger pump N which is 6¾ inches in diameter and 12 inches in stroke and is driven at 40 revolutions per minute through

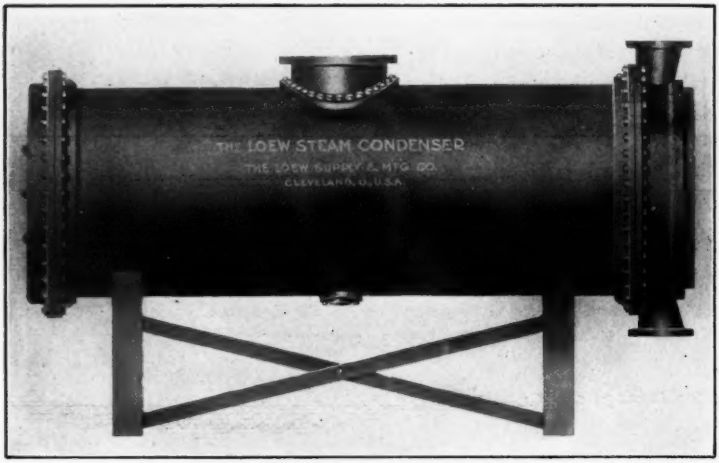


FIG. 13. THE LOEW SURFACE CONDENSER.
Loew Supply & Manufacturing Co., Cleveland, O.

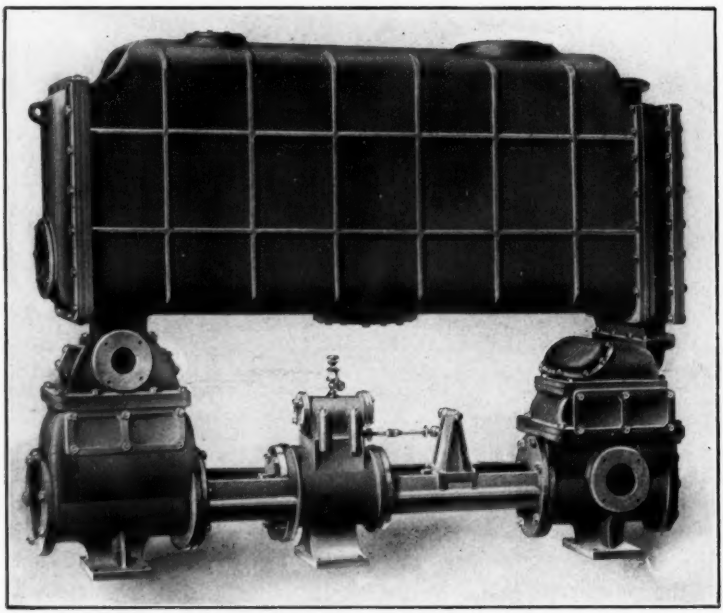


FIG. 14. BLAKE-KNOWLES RECTANGULAR SURFACE CONDENSER, MOUNTED OVER COMBINED AIR AND CIRCULATING PUMPS, ADMIRALTY STYLE.
International Steam Pump Co., New York.

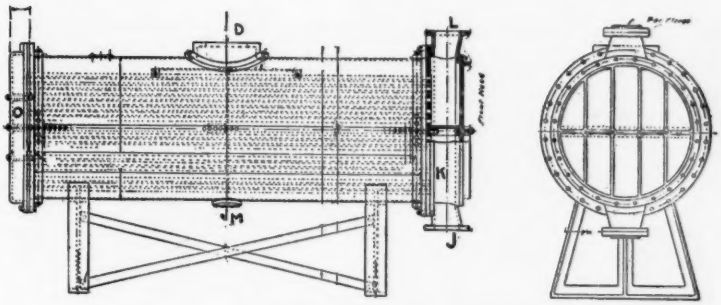


FIG. 15. SECTIONAL DIAGRAM OF LOEW CONDENSER.
The steam inlet is at D, the condensed water being drawn off at M. The circulating water is introduced at J, passes through the multitude of small tubes to the bonnet O, returns through the upper tubes, and makes its exit at L.

gearing from the air-pump crank shaft, which is itself driven at 100 revolutions per minute through single-reduction gearing by the electromotor O. The inlet of air to the cylinders of the air pump is controlled by a D slide valve arranged in a trick port to equalize the pressure at the ends of the cylinders at the end of the stroke. The discharge valves are automatic and controlled by springs. It is expected that 110 pounds of water will have to be circulated through the condenser for every pound of steam condensed. Centrifugal circulating pumps are employed which are placed at some distance from the condensers and are not shown in the drawings.

A form of surface condenser which is of comparatively recent date and which is very small and light for its capacity is the Ljungström condenser. This condenser consists of a number of rectangular plates which are corrugated diagonally and arranged with suitable spacing frames within a casing. Figure 16 shows some of the plates and spacing frames. It will be seen that every frame has two opposite sides

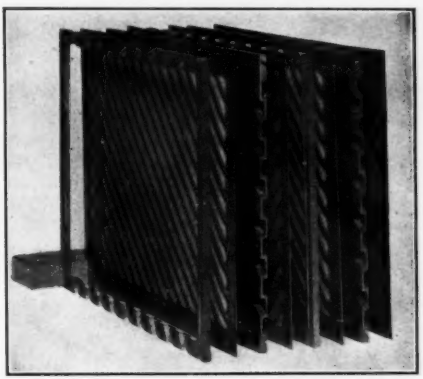


FIG. 16. PLATES AND SPACING FRAMES OF LJUNGSTRÖM SURFACE CONDENSER.

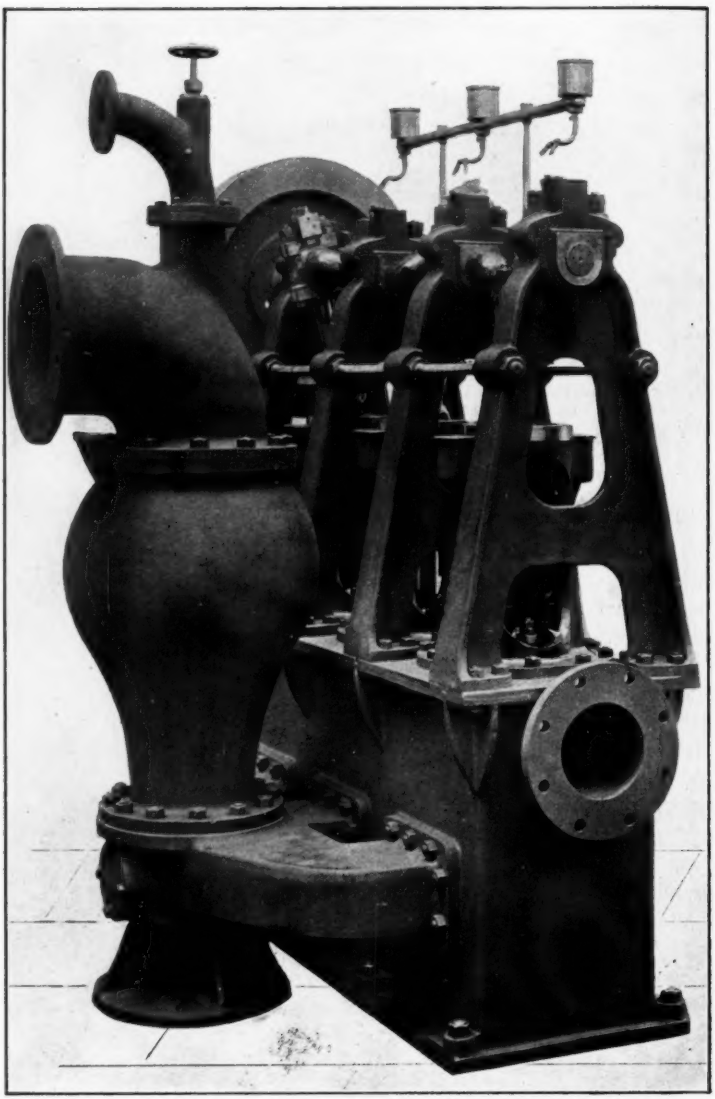
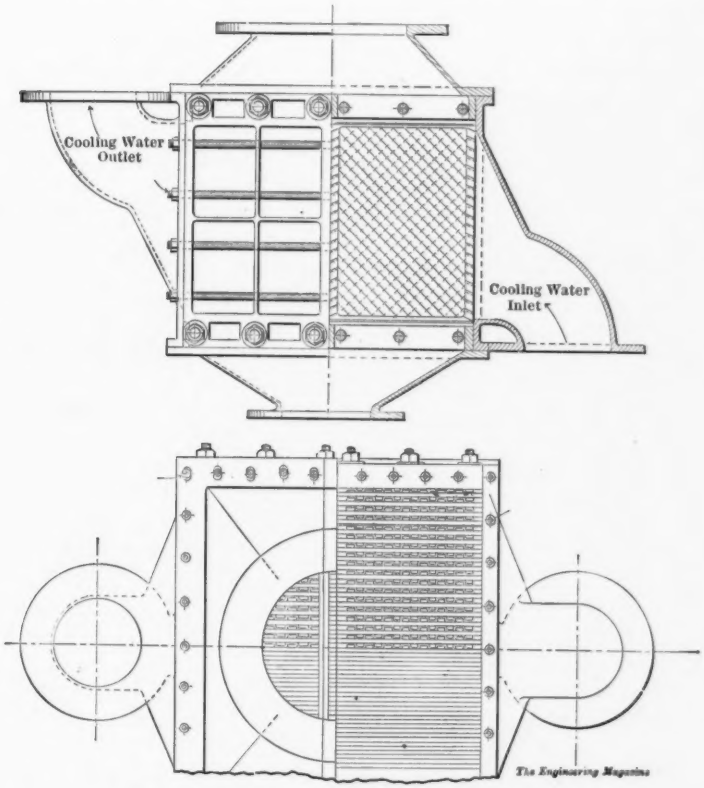


FIG. 17. JET CONDENSER AND DIRECT MOTOR-DRIVEN EDWARDS AIR-PUMP.

To deal with 8,000 lb. of steam per hour and maintain a vacuum of 27 in. with injection water at 65° and the barometer at 30 in. The Edwards Air-Pump Syndicate, London.



FIGS. 18 AND 19. LJUNGSTRÖM CONDENSER PLANT.
The upper figure shows an elevation, partly in section; the lower, a plan, with half the cover removed.

solid and the other two sides shaped in zig-zag fashion, and the alternate frames have different pairs of sides so arranged. Consequently when the plates and frames are clamped together, some of the chambers between the corrugated plates are open at the top and bottom and the other chambers are open at the sides. The steam to be condensed is passed through the one set of chambers and the condensing water is passed through the other set. The corrugations on the plates run alternately in different directions at right angles to each other and the corrugations of any plate touch those on the plates on both sides of it. The steam and water in their passage through the condenser are therefore very much broken up. The

plates are made up in a set or "bunches" and a condenser may consist of one or more bunches. Figure 22 shows a Ljungström condenser composed of two bunches, each with 73 plates. Figure 18 is an elevation, partly in section, of this condenser and Figure 19 is a plan with half of the top cover removed. The casing is made of phosphor-bronze. The exhaust steam enters at the top (in Figure 18) and passes downwards through every alternate chamber between the plates. The bottom flange is for connection to the pipe leading to the air pump. The circulating water enters at the right (Figures 18 and 19) and leaves at the left after passing through the intervening chambers between the plates. This condenser was recently supplied by Messrs. Dunford & Elliott, of Newcastle-on-Tyne, to the Russian Admiralty, to be installed on board one of the vessels of the Baltic fleet. The weight of the condenser empty is about 4¾ hundredweights and it is designed to deal with 5,000 to 6,000 pounds of exhaust steam per hour.

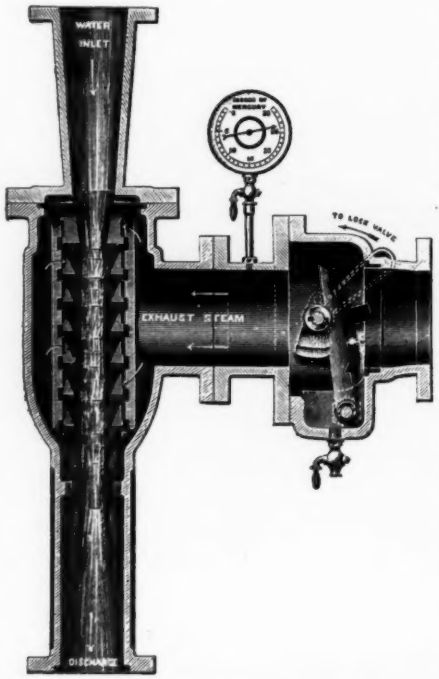


FIG. 20. LEDWARD'S EJECTOR CONDENSER.

The yacht Snowdrop II has quadruple-expansion engines designed to indicate 420 indicated horse power at 900 revolutions per minute. A Ljungström condenser has been fitted on board this yacht by Messrs. Simpson, Strickland & Co. to deal with the exhaust steam from these engines. This condenser has a cooling surface of 130 square feet and weighs 4.05 hundredweights empty and 4.94 hundredweights when filled with water. The outside dimensions of the casing are 38 inches by 18 inches by 13 inches. This condenser has, it is said, been able to

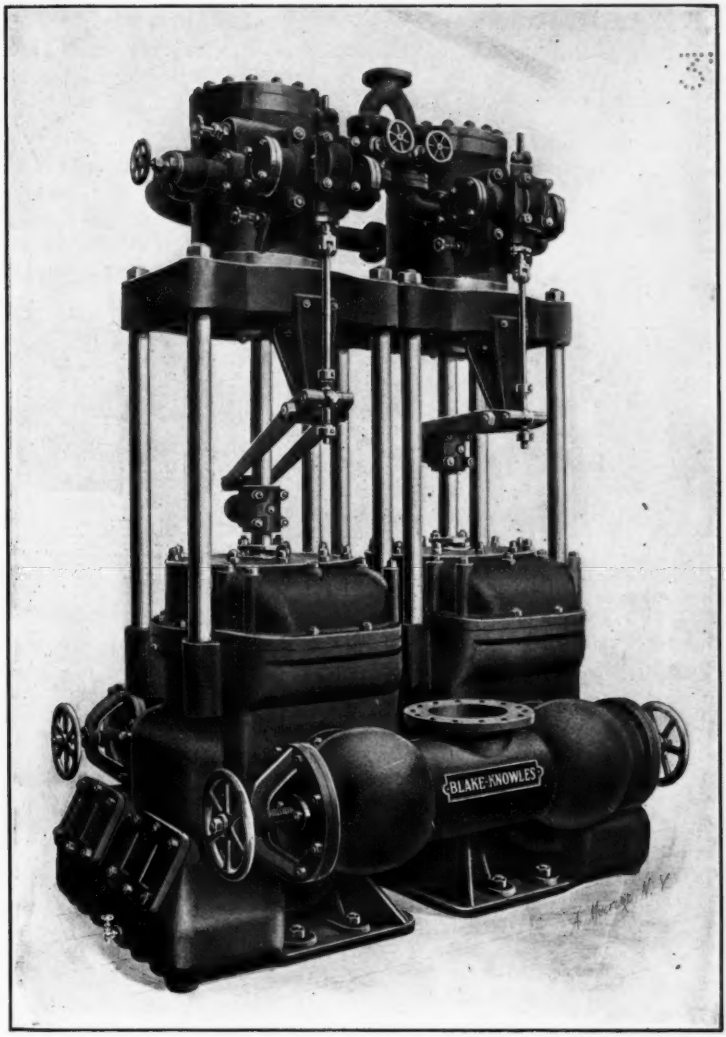


FIG. 21. BLAKE TWIN AIR PUMP FOR 8,000-HORSE-POWER ENGINES.
Double-acting "suction valveless" pattern. Either side can be run separately if desired.
International Steam Pump Co., New York.

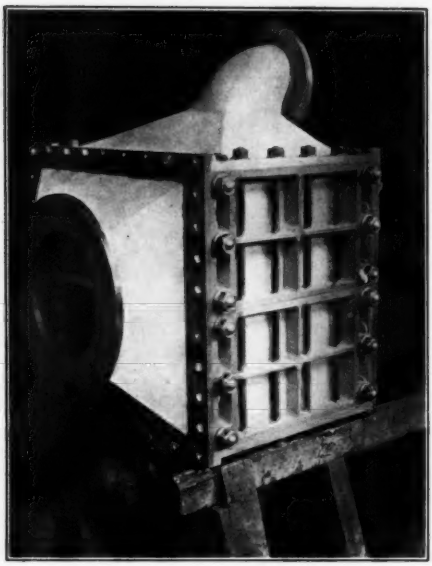


FIG. 22. LJUNGSTRÖM SURFACE CONDENSER FOR A RUSSIAN WARSHIP.

maintain a vacuum of 22½ to 23½ inches of mercury at full load, and a very much higher vacuum under cruising conditions.

A convenient type of condenser to use in many cases is the ejector condenser. An ejector condenser is simple and cheap and takes up little room. No air pump is required with it, and if a sufficient head of condensing water is obtained no pump is required for this either. There is then no moving part at all. Ejector condensers require about 25 or 30 pounds of water per pound of steam condensed. It is very important that the condensing water should be cool. An ejector condenser as made by Messrs. Ledward and Beckett, Ltd., of London, is shown in Figure 21. The condensing water, preferably under a head of 15 or 20 feet, enters at the top and the steam enters at the side. A number of conical passages are arranged in which the steam meets the water and is condensed, the combined fluids being discharged at the bottom. A check valve is shown at the right of the figure. This closes automatically if the condenser should suddenly cease to work through failure of the water supply. A back rush of water to the engine is thus prevented. The valve can be locked closed by a cam and lever when the engine is working non-condensing.

THE QUESTION OF THE GAS TURBINE.

By Prof. Sidney A. Reeve.

Professor Reeve's research, experiment, and practical work in the development of the gas turbine have been more than once noted in these pages, and are too well-known to need further citation. The present article will be recognized as a very valuable contribution to the knowledge of the subject. So far as concerns the dry-gas turbine, it is in direct reply to Dr. Lucke's paper which appeared in our issue for April last. Dr. Lucke, it will be recalled, expressly excepted from his discussion all reference to the problem of the turbine in which the products of controlled combustion were mixed with steam.—THE EDITORS.

THE promise held forth by the much talked of but as yet invisible gas-turbine cannot be rightly estimated without a correct knowledge of the true position occupied by its forebear, the steam-turbine. It is worth while to review briefly the reasons for the latter's existence.

It is well-known that the prime problem of steam-engine design, from the days when James Watt first established the fact until now, has been that of cylinder-condensation. This phenomenon is due wholly to temperature-fluctuation within the cylinder. Consequently the steam-turbine, maintaining, as it does, a sensibly constant temperature at each point in the course of the steam at all times, constitutes the only natural and complete solution to the problem. In steam-turbines the detrimental phenomenon, instead of consisting of a decrease of entropy from loss of heat in condensation, consists in an increase of entropy from fluid-friction.

In addition to this point the comparison between piston-engine and turbine rests upon the purely mechanical feature of the high rotative speed of the latter, with its consequent reduction of dimensions and freedom from vibration. For the present it is sufficient to state that this feature now appears in the light of a disadvantage and a problem, almost as much as it does as an advantage, taking all services together. At any rate, we are here chiefly concerned with the thermodynamics rather than with the mechanics of the question.

The rapid evolution and the marked success of the steam-turbine, occurring at practically the same time as the development of the internal-combustion engine, have frequently led to the natural question: "Why not a gas-turbine?" Before attempting to see if this

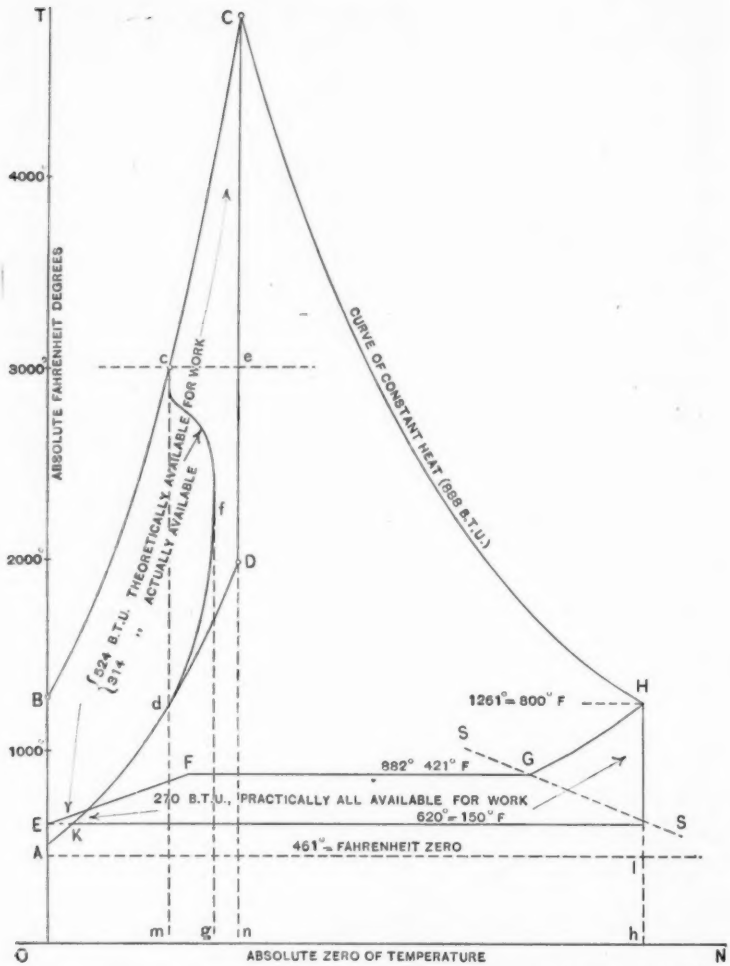


FIG. I. DIAGRAM OF ACTION OF ONE POUND OF PERMANENT GASES AND 0.636 POUND OF WATER.

314 B. t. u. utilized (cycle ABcfd) is the equivalent of about 11 cu. ft. of city gas per horse-power hour. This is what a piston-engine working on the Joule cycle to 300-lb. pressure might expect to do. 270 B. t. u. utilized (cycle AEFG-HIKA) is the equivalent of about 13 cu. ft. of city gas per horse-power hour, which is what the water-cooled gas-turbine might be expected to do. Both cases neglect friction-losses of the mechanical sort.

suggestion be possible of adoption in practice, it is necessary to inquire: "Is it desirable?" Is the situation between gas-turbine and gas-engine the parallel of that between steam-turbine and steam-engine?

In the explosive type of gas-engine, the cylinder-wall action, which is the exact physical parallel of the cylinder-wall or condensive action in the steam-engine, plays a very different role from it in the thermodynamic efficiency of the engine. In steam-engines the temperature-range is lower than is desirable. Therefore it is necessary to conserve temperatures at all costs. "Keep the cylinder as hot as the entering steam," said James Watt, one hundred and forty years ago; and ever since then we have been trying to do it. But in the gas-engine the situation is quite reversed. Our greatest problem is that involved in the excessive temperature. We are forced to keep it down at any cost, even at the cost of valuable heat. Therefore we enclose the cylinder in a water-jacket, and into this jacket is thrown all heat developed above a certain permissible maximum temperature, thereby to go to waste.

Herein comes the action of the cylinder walls, as the redeemer of an otherwise bad situation. The temperature within the cylinder is so very high at the instant of explosion that the heat interchange with the walls is exceedingly active. The thin film of the interior surface attains a temperature probably from 1,000 to 3,000 degrees higher than that of the external surface. Therefore, no sooner has the working flame expanded and dropped appreciably in temperature than it finds the latter maintained by its envelope of very hot wall-surface. So hot is this surface and so active the return of the stored heat to the expanding gases that the latter frequently expand almost isothermally *at the maximum temperature permissible within the cylinder,* and in doing so succeed in returning to the piston, as work, an important fraction of the heat which the walls had already necessarily abstracted in order to keep down maximum temperatures and which would otherwise have been entirely wasted. So marked is this action that it is safe to say that, excepting the degree of compression, it is the one factor most active in making gas-engine efficiency what it is today.*

* Note: See Trans. A. S. M. E. 1903, page 171, and the author's "Thermodynamics," pages 293 to 300, for further exposition of this fact. The substance of the argument stated in these references may be summarized as follows, referring to Fig. 1, which may be utilized to represent in entropy temperature coordinates the action of the Otto cycle. Therein let the closed figure *ABCD* represent the theoretic thermodynamic action of the standard Otto cycle, *AB* representing adiabatic compression, *BC* the rise of temperature and increase of entropy in combustion, *CD* the adiabatic expansion and *DA* the final cooling of the gases

It is therefore obvious that the gas-turbine has no opportunity to offer an advantage over the reciprocating gas-engine such as the steam-turbine offers over the steam piston-engine. This being so, is the development of a gas-turbine a desirable thing? If it is a desirable thing, is it possible? In reply, we would say that we think that it is desirable. Even if it is true that the device does not promise advantages equivalent with those offered by the steam-turbine, yet it still offers advantages, and for some special services it could offer peculiar ones which would be attainable by no other type of heat-motor.

As to the possibility, or rather the practicability, of the gas-turbine, that must be debated upon two lines—the thermodynamic and the mechanical.

Thermodynamically, there is no reason why a gas-turbine cannot be operated with as good an efficiency as any of the known heat-motors. It is first to be stated, however, that the standard Otto cycle is not the one applicable to the problem in hand. It is necessary to refer here again to the facts already cited—namely, that an important fraction of the motive power active in the expanding gases of the explosion-engine depends upon the fact that the gases are at work in the chamber in which they have just burned. The fundamental importance of this fact in the discussion is shown by the universal failure of all past efforts at the compounding of the explosive engine. These attempts have been made by men of unquestioned skill, have absorbed large sums of money, and have been made upon a scale commensurate with the importance of the problem, one such engine, at least, having been rated at over 600-horse-power. Yet they have all failed because of the collapse of the working gases so soon as they were divorced from the locality in which they had burned. Their high-temperature heat, coupled with small specific heat, proved to be entirely unreliable for the purposes of transmission from high-pressure to low-pressure cylinder. Since the operation of a gas-turbine

during exhaust. The maximum temperature, at *C*, is egregiously greater than any permissible in a working cylinder, even if intermittent. Let it be assumed that *ce* is the maximum temperature-level possible. Then a water-jacket must be provided sufficiently active to reduce temperatures from *C* to *c* by the abstraction of heat. In doing so, however, there would be involved the complete waste of the heat measured by the area *nCcm*, or of the heat available for work *CcdD*, which last is an important fraction of the entire heat available for work, *ABCD*. This having been done, however, and the process of temperature-rise from combustion having been limited to *Bc*, the beneficial effect of the wall action is shown in its distortion of the ensuing expansion from the adiabatic *cd* to the almost isothermal *cf*, whereby there is returned to the working gases the heat measured by the area *mcgf*, or the heat available for work of *cfd*. In other words, the wall action brings about automatically a fair approximation to that isothermal flat top to the cycle which Mr. Diesel recognized as of such great value when he projected his heat motor.

upon the explosive cycle necessarily includes, so far as we can see, the combustion of the gases in one locality and their expansion in another, it will be taken as settled that the explosive cycle is out of the question.

The one other cycle naturally turned to from the Otto is the constant-pressure cycle, variously known as the Joule, the Brayton, etc. In this cycle the compression must carry the working substance adiabatically to the highest pressure of the cycle; then follows the addition of heat, presumably by internal combustion, under constant pressure and with increasing volume; then follows adiabatic expansion to atmospheric pressure as a quite separate process.

It is first to be noted, in connection with this cycle, that in order to compete successfully with its explosive rival, it must operate with practically the same pressure-range. For modern gas-engine practice of the best sort, this may be taken as from atmospheric to 400 pounds per square inch. Given a range of pressure and temperature equal with that of the Otto cycle, the Joule is far superior to it in efficiency; but when its pressures are limited to anything like those attained at the end of compression in the Otto cycle, it is a complete and hopeless failure, and would be even if carried out in an engine of ideal construction. It is this fact which explains the many recorded failures with the constant-pressure cycle in the past. The one temporary success, the Brayton engine, worked to 80 or 90 pounds per square inch; and when the Otto "Silent" engine appeared, compressing to 30 or 40 pounds per square inch and exploding to 150 or 200, the defeat of the Brayton was immediate. That even today there should still be put forth experimental turbines and piston-engines attempting to operate upon this cycle with working pressures of from 40 to 100 pounds per square inch is remarkable evidence of how blindly money is wasted in mechanical experiments, without regard to the costly failures of previous experience or to the plain dictates of thermodynamic science.

Given, however, a range of pressure and temperature equal to that of the Otto cycle, there is no thermodynamic obstacle whatever to the operation of a gas-turbine upon the Joule cycle with an efficiency superior to that of the explosive piston-engine. Since there has recently appeared in these pages, however, an article* by one of the authorities taking the opposite view, it is worth while to stop and controvert its error.

* "Practical Investigations of the Gas-Turbine Problem," by Dr. Charles E. Lucke, April, 1905, page 96.

This error lies in a confused use of the term "free expansion." The free expansion of the expansion-valve of the refrigerating machine and the free expansion of the steam-turbine nozzle are assumed by Dr. Lucke to be the same process. Further, each of these processes is assumed to be a simple one. As a matter of fact, however, the two are quite different, and each is duplex in its nature. It consists primarily of a pure adiabatic expansion, developing the normal temperature-drop of adiabatic expansion and converting the normal amount of energy into velocity of flow. In both of the devices referred to, velocity of flow is no sooner attained to an appreciable degree than fluid friction is incurred, reconverting more or less of this normal quantity of energy into heat. But between the expansion-valve of the refrigerating machine, or the orifice of the throttling calorimeter, and the expansion nozzle of the DeLaval turbine there are two important differences, viz.:—

I. In the former the reconversion of energy into heat occurs upon such a scale that *all* of the mechanical energy developed in the adiabatic expansion is thus retransformed, whereas in the turbine nozzle the process is merely incidental and covers only that minor fraction of the energy handled which the most skilful design fails to avoid.

II. In the handling of saturated steam or ammonia-vapor, the increase of entropy involved in this dissipation occurs *without rise in temperature* (and in superheated steam nearly so), whereas in the handling of the permanent gases the reconversion returns the temperature almost, but not quite, to the original one at which adiabatic expansion began.

From the second of the two phenomena just mentioned Dr. Lucke has observed that the temperature-drop with permanent gases in frictional expansion is very slight. To this situation he applies the familiar formula for efficiency:

$$F = \frac{T_1 - T_2}{T_2},$$

although the latter holds true only with purely adiabatic cycles. Therefore, he concludes, frictional expansion is of no value for the gas-turbine, because it develops little temperature-drop. On the other hand, he observes, frictional expansion with saturated or wet vapors develops a marked drop in temperature. Therefore, he concludes, it would be (and in the turbine nozzle it actually is) of great value for power-development, offering the efficiency expressed by the above equation just as does adiabatic expansion.

It is hardly necessary to point out the error of this position. Frictional expansion is worthless for power-development, whatever may be the working substance or the device employed and whatever may be the temperature-drop which it develops. It occurs only when all of the heat which has been already converted into work has been subsequently reconverted into heat, with a thermal efficiency of 100 per cent. and a thermodynamic efficiency of zero. But the turbine nozzle does not embody frictional expansion, except as a quite minor and unavoidable detriment. Further, the temperature-drop which is available for doing work, and its efficiency, in adiabatic working is the same for any one substance and any given pressure-range, whether it be steam or gas, *without regard to whether the process be carried out in a cylinder, pushing a piston, or in a jet-producing nozzle.*

It is true that in actual practice the nozzle-expansion of the hypothetical gas-turbine may not be expected to develop a temperature-drop quite equal to the theoretic one of the pure adiabatic process; but the same must be said of the working expansion-cylinders of either the air-refrigerating machine or of the compressed-air motor (when not preheated), both of which Dr. Lucke attempts to contrast so strongly with the former. The latter two will incur slight in-leakages of heat in the form of heat, thus raising the terminal temperature above the theoretic; the former will incur a slight in-leakage of work in the form of heat, from fluid friction, to the same end. Instead of constituting a marked contrast they form a close parallel.

Therefore, it is to be repeated, the possibility of developing good thermodynamic efficiency in the gas-turbine, by maintaining nozzle or guide-blade expansion in either one or several stages, is an exact parallel with that of the piston-engine operating upon the same thermodynamic cycle; it is equally promising in theory—it equally involves constructive difficulties and detriments in practice.

Turning now to these constructive questions, it appears that the obstacles in the way of the gas-turbine lie in two directions, viz.:—

I. In the apparent necessity of expansive working from very high initial temperatures, with practically simultaneous development of power.

II. The constructive difficulty of compressing supplies to high pressure, either in rotary compressors operated at turbine speeds or in a reciprocating compressor operated by reduction-gearing.

As to the first, let us refer again to Figure 1. The outline cycle *ABCD* therein has already been used to represent a theoretically per-

fect Otto cycle, but it was originally drawn to scale to represent a theoretically perfect Joule cycle. It shows how the process of combustion *BC* would develop a temperature theoretically over 5,000 degrees F. and actually in the neighborhood of 4,000 degrees. It is at first sight impracticable to consider the injection of such a working fluid into a turbine, the vanes of which must practically attain the temperature of the gases (since the latter are not intermittent in their action), or temperatures somewhere intermediate between *C* and *D*. A second thought brings the suggestion that if we should develop all of our expansion in a single nozzle, as is done in the DeLaval turbine, we should then have to feed into the working parts a fluid having a temperature no higher than D. This suggestion has been largely worked upon, and considerable effort has been expended in trying to find some constructive material which would permit such a plan of operation. It is my opinion, however, that the outlook in this direction is not promising.

There is another way out of the situation, however. Let it be supposed that into the hot products of combustion of the Joule cycle, with its flame developed under high but constant pressure, there be injected a proper quantity of water, much as is done in the cylinder of the Bánki motor operating upon the Otto cycle. A much more stable method of accomplishing the same result was illustrated in THE ENGINEERING MAGAZINE for February, 1904, page 667. The thermodynamic principle involved in either process is exactly that of the steam-boiler and furnace, except that in the latter the flame is under atmospheric pressure and transmits its heat to the water through the boiler-walls, whereas in the former the flame exists under the same pressure as the steam and transmits its heat to the water by direct contact. Further, in the latter the resultant product is pure water-vapor, whereas in the former the product is a mixture of steam with nitrogen and carbonic acid. Either process consists, thermodynamically, in an exchange of narrow entropy, or small heat-mass at high temperature, such as that indicated at the point *C* as the product of the internal combustion of the Joule cycle, for the wide entropy or greater heat-mass moving at a lower temperature or velocity, such as is indicated by the point *H*, of Figure 1. That is to say, the heat-area *OBCn* has been exchanged for the heat-area *OAFGHh*. In this particular case it has been assumed that the steam thus formed is appreciably superheated, the point *G* being that of saturated steam for the prevailing pressure.

If, now, this fluid be expanded throughout the same range of

pressure as was originally contemplated, in any standard type of turbine, the adiabatic drop involved will be that shown by the line *HI*, as a substitute for *CD* of the dry-gas turbine. The cycle developed will be *AEFGHIKA* as a substitute for *ABCD*. The change has reduced our demands upon the working parts of the steam-turbine, as regards durability against high temperatures, from the temperature D or higher to something intermediate between H and I. It is true that the theoretic efficiency has been somewhat decreased. It has not been decreased, however, in anything like a proportion with the decrease in temperature. This is one of the errors fallen into by even so eminent an authority as Dr. Stodola.* That the actual efficiency attainable in practice, moreover, might be as great as or even greater than in the dry-gas turbine there is reason to expect from the following considerations.

It is to be remembered that the working fluid of the dry-gas turbine is one of very low specific gravity. Consequently, when called upon to absorb in kinetic form the full energy developed by its own adiabatic expansion, and especially if this must be completely performed in one stage, the resultant velocity will be enormous. This is one of the objections which has been urged as fundamental against the gas turbine, in more than one treatise upon the topic. The peripheral velocities which would be called for in order to properly develop mechanical energy from such a dry-gas jet would be far beyond those very high ones to which we have already become accustomed in steam-turbine practice. Moreover, since the one loss of turbine thermodynamics, friction, increases with the velocity, we could not expect the expansion in such a nozzle to remain so purely adiabatic as is the case with steam. The proportion of the theoretic efficiency practically obtainable would be much less than in the steam-nozzle.

In the case of the mixed fluids, however, conditions are quite different. The total amount of energy to be developed by adiabatic expansion is no greater than in the original dry gases; indeed it is somewhat less. At the same time, the molecular mass of the fluid has been very much increased by the intermixture of the steam. Therefore the velocity requisite to absorb the energy thermodynamically developed will be not only a mere fraction of that called for with the dry gases, but it will be even less than with pure steam. The beneficial effect of the process, therefore, upon peripheral and rota-

* "The Steam-Turbine, with an Appendix upon the Gas-Turbine and the Future of Heat-Engines," Stodola, page 416.

tive velocities is obvious.* Volumes indeed would be somewhat greater than with pure steam, although less than with dry gases; but one of the prime characteristics of the turbine being the ability to handle large volumes without the usual cost in apparatus and friction, it may be taken as safe to dismiss this point as constituting no obstacle.

In my opinion, the gas turbine is a machine immediately practicable, both thermodynamically and mechanically, with the sole exception of the question as to the compression of supplies; and this is a question in regard to which there is little to be said at present. The several paths to solution are plainly open to the constructive engineer. What he may be able to make of them is entirely a question of individual skill. That they will be developed and their obstacles properly overcome, with a little time and patience, there is but the slightest doubt. Indeed, the prime object of the present article is to point out clearly that in this mechanical field, and not in the thermodynamics of the case, lie the true obstacles. These last are numerous enough and rigid enough. It is desirable to forefend any more wandering abroad in useless endeavor against obstacles which do not exist, in place of concentrating all attention upon those legitimate ones which must inevitably confront effort, in so novel a field of invention as the gas-turbine.

* The situation has been described in popular language as this: That each molecule of dry gas takes unto himself a wife (of steam) and is forced thereby to abandon his fast career and to settle down to a slower but more effective gait.

EDITORIAL COMMENT

THE Seventh International Railway Congress, held at Washington during the past month, was an event which demands comment for several reasons. It was the first meeting of the congress in the United States, and it was the first meeting of this important organization in which anything like a proportional part has been taken by American railroad men.

So far as the value of the professional sessions and papers is concerned, an examination of the proceedings and discussions must fully demonstrate that all departments of transportation will benefit greatly by the work of the congress. The reports presented were divided into classes, according to their relations to track and works; to locomotives and rolling stock; to operation; to light railways; and to general matters. Each of these classes contained several subdivisions, and numerous voluminous papers were presented, the entire proceedings constituting a mass of valuable matter upon the important present problems in railroading.

Of the great value of a systematic discussion of these questions by a gathering of nearly one thousand specialists, representing all countries in which railways are scientifically operated and studied, there can be no doubt; and while the congress itself lasted but ten days, its works will follow it, supplemented as it was by a notable exhibition of American railway appliances and by extensive tours of the visiting delegates to all parts of the country.

This is not the place to consider in detail the work of the congress, but attention may be called to the fact that among the subjects discussed were some of distinctly international significance. Thus, the four-cylinder balanced compound locomotive, just beginning to receive serious consideration at the hands of American railroad engineers, has been firmly established in Europe for a number of years, thanks to the brilliant pioneer work of such men as De Glehn, Du Bousquet, and others, and the hesitancy of some American railroad men in discussing the value of such engines was in marked contrast to the assured confidence of the European engineers who have had the benefit of favorable experience.

Again, the hitherto unquestioned reign of the Stephenson link motion is being disputed in the United States by the successful applications of the Walschaert valve gear, a motion which, on the Continent at least, has long since held the first place as an effective means of operating the slide valve by a simple mechanism entirely outside the frames. If these features alone become impressed upon American railroad practice, the educational value of the congress, so far as the United States is concerned, will have been fully demonstrated.

The relation of light railways to main trunk lines, and the extent to which they may be profitably utilized as feeders, was another topic, and the practical experience obtained in Austria-Hungary demonstrated the wisdom of encouraging, instead of antagonizing, such adjuncts to the comprehensive problem of transportation. In this connection the employment of motor cars as auxiliaries in railroad operation was brought out, and there

is little doubt that this department of work will occupy a much greater portion of the deliberations of the next congress, five years hence in Switzerland.

* * *

It is to be hoped that the auspicious beginning made at this congress will continue, and that American railroad men will hereafter broaden their horison, and enter more fully into the development of their profession in other parts of the world. The railroad engineer, probably by reason of the intense application demanded by his work, has a marked tendency to become self-centred to a high degree, and to pay far too little attention to what is going on outside of his immediate circle and land. From this position it is but a short step to that of isolation and to the acquirement of the idea that the practice with which he is surrounded is the best possible to be had. It does such men good to be brought into close contact with men of other lands, and to find out that the things which they are trying to do are being done as well, and sometimes better, by others who may be employing entirely different methods.

* * *

Mr. Lindon W. Bates' project for the Panama Canal, to which we referred very briefly last month, has been since then fairly presented in several of the weeklies and perhaps is already so well understood as to need no recapitulation. Briefly, it differs from preceding projects—all of which he rejects—in the following essential points:—

1.—He would extend the summit level (at an elevation of about + 20 feet) entirely across the isthmus from tide to tide, by throwing low barrages across the valleys of the Chagres and the Rio Grande. This would give two terminal lakes, to be joined of course by an excavated central canal section; the projects heretofore advanced have contemplated a central summit lake, placed between two tide-level canal sections. The terminal lakes in the Bates project would be entered and left by twin locks, directly at the terminal seaports, these locks being placed in solid ground away from the undersluice-regulated barrages, and radical changes being made in the proposed disposition of the harbors to meet the new location. In the main, these lakes would receive directly and regulate sufficiently the inflow from the lower tributary streams, though special regulating works would be provided for the Rio Cano. A "B" variant from his "A" project combines with it the already familiar summit lake, at an elevation of about + 50 feet, but the former project is the one which Mr. Bates regards as the best solution.

2.—He would control the upper Chagres by comparatively low, undersluice dams at Gamboa and Alhajuela, instead of by high, impounding dams with spillways at the same points. Thus the regulating basins behind the dams would be normally empty, instead of normally full, as always heretofore proposed. A further feature of his plan is the excavation of a considerable basin at Obispo, immediately below the Gamboa dam, in which the regulated flow from the upper Chagres can be received, and directed, one-half toward the Pacific and one-half toward the Caribbean, through channels of compensated water-section.

These appear to be the salient differences between Mr. Bates' project and any other which has been proposed, and it is manifest that they are so fundamental as to make a wholly new mode of attack upon the problem. Supposing it to afford a solution of the essential conditions, it seems to promise many important advantages. From the point of view of navigation, it makes the lockage time coincident with the necessary delays at the canal terminals, and it affords comparatively free lake navigation for about 17 miles of the total transit—nearly 5 miles

more than would be afforded by Lake Bohio at the 90-foot level. From the point of view of construction, it reduces the dams to so low a head that foundation difficulties almost disappear, and it utilizes to the maximum the work already done by the French company. From the point of view of sanitation, it drowns most of the swamps near the terminal cities and thus remove one of the most prolific causes of disease.

It will almost inevitably strike the reader, however, that Mr. Bates takes surprisingly little cognizance of the huge excavation demanded by his plan. The quantities would certainly be an extremely large fraction of those involved in a sea-level canal, which he elsewhere characterizes as "too appalling to contemplate." And beyond this, the supreme and vital question is:—would the projected regulation works meet the requirements of the regimen of the Chagres and the assured and uninterrupted navigation of the canal, under conditions of maximum and of minimum rainfall? To our minds, Mr. Bates does not present a convincing demonstration on these points. It is a matter in which the most careful and accurate quantitative analysis of the data is essential This Mr. Bates may have made, but it does not seem to us to be presented in his monograph; and until it has been thus rigidly tested, no project can be more than an interesting possibility. Certainly Mr. Bates' project offers many advantageous features, and if feasible and adequate to the conditions, deserves most careful consideration; but the only thing to be done is to commit it to the board of consulting engineers, for critical but impartial examination.

* * *

THE appointments of Gen. Henry L. Abbot and Mr. Isham Randolph to this advisory board, just announced, are cause for general satisfaction and sincere congratulation. Mr. Randolph brings to the work a fund of practical experience in the successful handling of closely similar problems, while General Abbot is unquestionably the highest authority on the climatic data of the Isthmus and the all-vital problem of the Chagres. It has been our pleasure and privilege to present some of his most important studies. We rejoice with the country that his fund of knowledge is to be made so fully available in the conduct of the great national enterprise.

* * *

THE purchase of materials for the Panama Canal is likely to play an unforeseen part, in putting the tariff-revision question upon a new basis, or at all events in a new light. The few figures cited by the Commission, to show how much they could save in cost of the canal by buying certain items abroad, have done more to enlighten the country upon the effects of the tariff and trust combinations than all the statistics of all the campaign orators since the tariff was made a party issue. Figures of the prices of steel rails at home and abroad, showing the excess burden of $6.00 a ton borne by the home buyer, have been made as familiar as the proverbial household words; but how many householders are ever interested in buying a steel rail? Here, however, is a great National undertaking in which each of us has his part and for which each is to pay his share. The sense of proprietorship enters, and policies and their effects become acutely interesting.

It is already made clearly apparent that many of the materials and some at least of the equipment can be bought much more cheaply in foreign than in home markets—sometimes even when they are originally of American manufacture. What are we going to do about it? Shall the Commission treat this phase of the construction just as we have been assured they will every other, with every energy centered upon the utmost economy and efficiency in

construction—upon building the best canal for the least money, and therefore with a free hand to buy in the cheapest market! Manifestly, that would be the course of any independent construction company. It would be the reasonable business policy. But is it the right policy for a Government committed to the "protection of home industries"? If they adopt it, are they not admitting that protection and its concomitants have produced conditions unfavorable to the economy of constructive work, from which it is advisable to escape whenever possible, and which, therefore (by natural inference) it would be well to remove from the country at large by abolishing the causes?

On the other hand, if they reject all foreign bids and buy in American markets at the greatly advanced prices cited, are they not manifestly burdening the work, in its present cost and its future earning power, with a large expenditure which might plainly have been avoided? Will it not be apparent that this addition to the cost, while it must be paid by the country as a whole, will go to the immediate benefit of a very few—practically, the United States Steel Corporation—and will not that of itself dampen the popular ardor for the present tariff?

Whichever horn of the dilemma be grasped, the tariff seems likely to come sharply into question; and the novelty in the matter is that the burden of proof seems to be thrown upon the "stand-patters."

* * *

We have reviewed elsewhere in this issue a paper upon high-speed railway trains, this being based upon the regular running speeds of some of the most noted trains of Europe and America, not taking into account special trains or phenomenal spurts which have been made independently of regular operating schedules. At the same time it is interesting to note that within a few days the train cited as the fastest train in the world, by the author of the paper referred to, the Atlantic City Flyer of the Philadelphia and Reading Railway, has beaten its own record upon the interesting occasion of the transport of a number of the delegates of the International Railway Congress to Atlantic City.

The regular running time of the train over the distance of 55.5 miles from Camden to Atlantic City is 49 minutes, an average rate of 67.9 miles per hour, this requiring speeds of more than 70 miles per hour for portions of the run to make up for the delays near the terminals. The train carrying the delegates of the International Engineering Congress made the run on May 14 last in 43 minutes, this giving an average speed of 77.4 miles per hour, with correspondingly higher speeds during parts of the trip.

Although these high speeds may often be considered as pertaining to the advertising element in railroading rather than to legitimate transportation, it is none the less certain that such trains do attract passengers to the roads on which they are run. The Atlantic City Flyer is patronized during the season by hundreds of passengers who use it regularly for transportation between Philadelphia and their summer homes by the sea, and in this way it has become recognized as a regular feature of the road. In like manner the Empire State Express, referred to in Mr. Kramer's paper as the fastest regular train for distances greater than 300 miles, has proved sufficiently satisfactory as a business proposition to cause the New York Central Railroad to add another similar train to the daily schedule. The question as to whether high-speed trains pay or not can be answered only by making the experiment and leaving the answer to the traveling public; and in these two cases, representing the two fastes trains in America, the response appears to have been wholly in the affirmative.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

PROGRESS OF THE PANAMA CANAL.

REPORT OF THE CHIEF ENGINEER UPON THE PROGRESS IN ENGINEERING AND CONSTRUCTION WORK AT THE ISTHMUS.

John F. Wallace—Isthmian Canal Commission.

THE report of the Chief Engineer of the Isthmian Canal Commission, published in pamphlet form by the commission and reprinted wholly or in part by the technical press, forms a document which, both by its official nature and its contents demands critical comment and review. The report brings the work down to February 1, of the current year, and includes abstracts of the reports of the several engineers who have been engaged at various points along the route during that period. These abstract division reports form the opening portion of the main document, and some of the more important features which they contain will be given, as upon them the general conclusions of the Chief Engineer are based.

After considering the report of Mr. List, concerning the harbor works at Colon, which present no serious difficulties, the investigations of Mr. Nichols at Gatun are taken up, these being mainly devoted to the examination of the valley of the Chagres in the vicinity of Gatun to determine the possibility of the construction of a dam at that point. The borings which have been made here, and further up the valley of the Chagres river, appear to show that the general nature of the route is that of a deep gorge filled with alluvial deposits and freely water-bearing material at such depths as to demand great caution in the selection of a site for a dam.

"The results of all the studies in the Chagres valley from Gamboa to Colon clearly point to the existence of a geological gorge, the bottom of this gorge being at an unknown depth between Colon and Bohio, but coming to within 163 feet below sea level at Bohio, and gradually rising to the level of the sea in the vicinity of Gamboa, borings having been made to a depth of 175 feet below sea level without discovering solid rock in the vicinity of Gatun."

Investigations made by Mr. Dose, resident engineer at Bohio, upon the practicability and cost of a high dam in that vicinity have been directed to two sites which appear to offer possibilities. Borings here show that there is little probability of finding satisfactory locations, since it would be necessary to go down 163 to 168 feet, and for at least 150 feet the soil is very porous and water bearing. Investigations at Buena Vista, farther up the valley, appear to indicate rock bottom at about 130 feet below sea level, but the borings at this point are not yet completed.

Mr. Wallace lays much stress upon the investigations in the vicinity of Gamboa, the work there having been done by Mr. Ehle to determine the possibility and advisability of a dam in that neighborhood, together with the construction of a tunnel spillway through the continental divide into the Pacific ocean. The results of these investigations are as follows: The construction of a dam up to the height of 200 feet at Gamboa is practicable and economical, bed rock being found at an elevation of approximately the level of the sea, and the configuration of the ground above the sea level giving a cross-section of the valley of

moderate and reasonable dimensions at this point. It is also considered possible to construct a tunnel spillway either through the continental divide to the Pacific slope with a maximum tunnel length of eight miles, or a tunnel spillway to the Caribbean slope with a maximum tunnel length of 3½ miles.

Mr. Wallace considers that the data obtained clearly demonstrate that the construction of a dam at Gamboa will satisfactorily and economically solve the problem of the control of the Chagres river, the provision of water for any low level lock-canal designed, and the supply of sufficient electric energy for lighting purposes, railroad operation, or the operation of machinery used in the construction of the canal, and he estimates that, for the construction of the Gamboa dam, including the Pacific spillway, $17,000,000 would be required.

The Culebra cut seems to have lost much of the terror with which it was formerly regarded, and it appears to be rightly considered that the real problem in the undertaking lies in the control of the Chagres river. At the same time it is doubtless correct to state, as Mr. Wallace does, that the excavation at Culebra practically controls the time required to complete the canal, since all the other works can be completed in the time required for the central Culebra division. A canal on the 60 foot level will require the removal of 111,000,000 cubic yards of material from Culebra, and this will be increased to 142,000,000 cubic yards for the 30 foot level, and to 186,000,000 for a sea-level canal. Mr. Wallace says that it seems safe and conservative to say that the summit level should not exceed 60 feet in height, but he also maintains that it is "self-evidently true that a sea-level canal is the most desirable in economy of maintenance, operation, time of passage through it, and simplicity of design, plan, and execution; that as a problem *per se* it is the only solution, the deterrent factors being time and cost."

Broadly the recommendations of the chief engineer at this time, for the favorable consideration of the commission are as follows:

1. That harbor facilities be at once provided in the vicinity of Colon by the construction of an inner harbor at Cristobal-Colon and by the construction of a breakwater at least 4,000 feet long, to protect the east side of the outer harbor.

2. That the work of completing the Gatun diversion be proceeded with at once.

3. That the location of a dam with the crest approximately 200 feet above sea level be decided upon at Gamboa; and that the work of construction be organized and commenced as soon as the plans for such structure have been approved by the commission.

4. Considering the fact that the Panama canal is intended to serve the commerce of the world through centuries yet to come; that it is not a commercial enterprise to be carried forward for the immediate benefit of the present generation; that the American nation haas voluntarily undertaken this great work, and that the question of merely a few years of time or a few million of dollars of cost more or less, should not be controlling factors, it would seem proper to treat the problem from a broad and liberal standpoint. Therefore, it is recommended that no temporary or tentative plan be adopted that will interfere with the final adoption of the sea-level plan, which it is hoped will ultimately receive the favorable consideration of the commission.

The report is characteristically direct and definite. It was, of course and properly, Mr. Wallace's purpose to state his propositions concisely, and not to argue them. By those to whom the same conclusions are not so clearly apparent, however, it may be regretted that the statement is necessarily so brief. It is not self-evident, for example, why the rather important item of retaining walls at the Culebra Cut becomes no greater in the sea-level than in the 60-foot-level estimate. More important, it is not quite apparent why the item of "Chagres and Gatun Diversions," fixed at $3,000,000 for the 60-foot level, remains at the same figure in the sea-level estimate; for in the latter case it would seem that the entire run-off of the Chagres valley below Gamboa—about one-third of the total discharge of the river—must be provided for outside of the canal, instead of being in large part received into the summit lake. And while

Mr. Wallace feels that the proposed control of the Chagres by the Gamboa dam and tunnel spillways "does not present any engineering problems that have not been already satisfactorily and repeatedly solved in various parts of the civilized world," those less accustomed to the project feel considerable anxiety concerning it—especially the feature of the assured control of a torrential river by an eight-mile tunnel through the character of formation existing on the Isthmus. And there still remains the whole watershed below Gamboa to be controlled, including the by no means insignificant Rio Cano.

We have no doubt whatever that Mr. Wallace can support his recommendations ably. We believe that one strong ground of his faith is the conviction that the sea-level canal is the ultimate ideal, and therefore that an engineering solution must be found for all the difficulties in the way. If indeed it be "self-evidently true that a sea-level canal is the most desirable in economy of maintenance, operation, time of passage through it, and simplicity of design, plan, and execution, so that as a problem *per se* it is the only solution"—then the case may be closed; but the evidence has disclosed itself differently to other very able students and specialists. Simplicity of design, stability of maintenance, facility of execution, have seemed to other engineers of the very highest standing to rest with one of the summit-lake plans. Here, too, they have found not only the enormous reduction of the great problem of the Culebra Cut, but in their judgment the most complete solution of the problem of the Chagres. And in the free navigation afforded by the summit lake for a large portion of the transit distance, they see a factor throwing the advantage of shorter time of passage and safer navigation also to the summit-level type.

It is doubtless in recognition of this that Mr. Wallace has chosen the broad-minded course of consulting with an international board of engineers particularly experienced in the problems of ship-canal management and navigation. We shall hope that the complexion of this board will be such that Mr. Wallace, quite as much as the country at large, will feel that the very best special knowledge and experience the world affords has been placed at his disposal for consultation and guidance.

RECENT PROGRESS IN METALLURGY.

A REVIEW OF THE DEVELOPMENT OF METALLURGICAL PROCESSES AND APPLIANCES DURING THE YEAR 1904.

H. Le Chatelier—Bulletin de la Société d'Encouragement.

IN accordance with the practice of the Société d'Encouragement pour l'Industrie Nationale there is contained in its *Bulletin,* and in its associated publication, the *Revue de Métallurgie,* from time to time reviews of the current development in the various departments of applied science. In a recent issue of the *Bulletin* we note an address by the well-known metallurgist, M. H. Le Chatelier, upon the progress of metallurgy during the past year, and from this comprehensive review we make some abstracts.

M. Le Chatelier calls attention to the fact that progress is made along two different paths, the one following studies in pure science, of which the application does not always immediately appear, and the other covering work which, while sometimes empirical, leads directly to results of practical importance and value. Both of these roads, however, lead to the same ultimate goal, and in many instances they approach very closely to each other. Thus, the practical man sees but little value in the researches of metallography, concerning which so much has been said and written of late, but it is none the less apparent to those who study the subject that this method of investigation is destined to lead to valuable practical results. That this is the view of men of hard practical views is seen by the fact that some of the largest manufacturing establishments have installed the methods of micro-photography into their laboratories.

The fact that steel is constituted in a manner similar to the rocks of which the

surface of the earth is formed, is now generally accepted, and the use of the microscope has shown that there are three principal constituents: ferrite, or pure iron; graphite, or pure carbon; and cementite, a carbide of iron. The various forms under which these three constituents appear have been the subject of much discussion, and the whole question of the study of the constitution of tempered steels is now in the hands of an international committee including in its membership some of the most eminent metallurgists of France, England, Germany, Sweden, Russia, and the United States.

The methods which have been applied with success to the study of the constitution of steel have also been used in investigation of bronzes, and it is believed that, by a combination of thermal, chemical, and metallographical methods important results will be obtained.

One of the most curious discoveries in the domain of metallurgy during the past year is that of Dr. Heusler in connection with the existence of magnetic alloys formed entirely of non-metallic elements. Thus an alloy of aluminum and manganese exhibits a coercitive force equal to about one-half that of iron. The alloy is too brittle and unstable to have any industrial value at present, but its discovery may lead to further developments of practical importance.

Among recent investigations of importance may be noted the studies of Boudouard and of Hahn upon the chemical reactions which occur in the blast furnace. The equilibrium of the blast furnace is a subject of the greatest industrial importance, and the relations of carbonic oxide, carbonic acid, vapor of water, and hydrogen to each other and to the solid carbon are only beginning to be understood.

There has been a notable increase during the past year in the application of the methods of electro-chemistry to the analysis of metals and materials of metallurgy. The use of the electric current enables numerous sources of error due to reagents to be avoided, while the employment of rotating electrodes has permitted a great increase in the quantity of deposited metal, by bringing the surfaces of the cathode continually into contact with fresh solution.

During the year there has been much important work done in the investigation of special alloy steels, and the studies of M. Guillet in this field have been especially noteworthy. To these must be added the excellent work of M. Guillaume upon the nickel-steel alloys, with especial reference to the control of the coefficient of expansion, both in the production of the alloy invar, of minimum expansion, and of the alloy platinite, having the same coefficient of expansion as platinum.

The discovery of high-speed tool steel, by Messrs. Taylor and White, dates back to 1900, but some important studies upon later steels of this class have been made during the past year. The papers of Mr. Gledhill, and the experiments by Professor Nicolson, as well as those of M. Demozay, have shown very clearly the extent to which such steels may be employed to accelerate the rate of production, and the dynamometric experiments of Professor Nicolson give valuable data for use in connection with the design of new and more powerful machine tools to enable the full possibilities of the new tool steels to be achieved.

In connection with methods of testing materials the most important advances have been made in connection with researches into the fragility, or brittleness, of metals. By the use of notched bars of small size, so that the stress is localized and the fracture effected by a single blow, it has been found possible to determine very closely the resistance to shock, and thus an important structural property of materials may be investigated. The improved method of Fremont for determining the elastic limit may be noted, this consisting in the subjecting of a pyramidal test piece to tension or compression, one face of the pyramid being brilliantly polished, and revealing, by the extent to which this surface is dulled, the location of the section corresponding to the elastic limit.

Along similar lines may be mentioned the researches of Professor Arnold upon the behaviour of metals under rapidly alternating stresses, these repeating in an experimental manner the theories of Wöhler. There is an undoubted tendency to assimilate the methods of testing materials

to the conditions which obtain in actual service, and the progress along these lines is evident.

The most important development in connection with the manufacture of iron is found in the Gayley process for supplying dry-air to the blast, removing the moisture by refrigeration. Practical tests have shown a saving of 20 per cent. of fuel by the removal of the moisture from the air supply of a blast furnace, but M. Le Chatelier calls attention to the fact that this corresponds to an average saving of only about 10 per cent., since the air is excessively humid for only about six months in the year. Nevertheless, he admits that the value of the improvement may be placed as second only to that of the introduction of the hot blast.

The principal development in electro-metallurgy during the past year has been in connection with the electric manufacture of steel. The cost of the electric smelting of iron renders the process unable to compete commercially with the older methods, but the refining of high-grade steel, especially when the electrical energy is generated from the waste gases of the associated blast furnaces, is altogether within the bounds of commercial possibility. The results which have been attained at La Praz, and at Gysinge, and the report of the Canadian Commission, show that steel produced by electrical processes may compete successfully with crucible steel produced by the older processes.

Broadly, the developments of the past year in the domain of metallurgy show a general tendency toward an increase in the power and productive capacity of the apparatus and the workshop. The output of blast furnaces and of rolling mills has increased, while the use of high-speed cutting tools in more powerful machines has correspondingly increased the productive capacity of manufacturing machine shops. The economic effects of such changes remains to be seen, and the possibility of over-production, with consequent lowering of prices, may not prove to be a commercial benefit. It is not impossible, however, that serious effects may be prevented by suitable agreements among manufacturers, while the extension of applications of the products and the consequent development of new markets will naturally follow.

UNSOLVED PROBLEMS IN ELECTRICAL ENGINEERING.

AN EXAMINATION OF SOME OF THE QUESTIONS UNDER SCIENTIFIC INVESTIGATION IN THE DOMAIN OF APPLIED ELECTRICITY.

Col. R. E. B. Crompton—Institution of Civil Engineers.

IN the course of the James Forrest lecture, recently delivered before the Institution of Civil Engineers by Col. R. E. B. Crompton, some of the important problems now being attacked by electrical engineers were discussed in a very interesting manner, and some abstract of the lecture will be found of value both for its direct interest and also for its suggestiveness to engineers and students.

Col. Crompton divides his subject into two parts, one dealing with the electrical problems which have been set for us by Nature, and the other including the questions which have arisen in the course of the efforts of engineers to use electrical energy for the service of man. The first class of problems naturally fall more especially into the domain of the physicist, especially the examples selected by Col. Crompton, the problem of lightning discharges, and the questions connected with the subject of terrestrial magnetism. Following upon these, and forming what may be termed a sort of connecting link between the work of the physicist and that of the engineer comes the subject of the etheric transmission of power.

"The development of electric-wave telegraphy is an excellent instance of the various stages of the solving of an electrical problem. In this case Maxwell and Hertz settled the first stage and formulated the laws of the transmission of etheric waves. Branly supplied an important element when he invented the coherer. Marconi's enthusiasm, skill, and perseverance, aided by Fleming and other numerous competent coworkers, have carried the third stage to its present development.

"We may consider that the etheric transmission of signals up to a given distance, and notably for the purposes of signalling to and between ships at sea, is practically solved, although there are many secondary problems arising out of it. No doubt the first and most important of these is the production of wave-trains sufficiently powerful and of the right character to yield the best results. Fleming has particularly devoted himself to this subject, and the value of his inventions has been fully acknowledged by Marconi.

"Taking the economical question first. Fleming has shown that in all probability the method that we have arrived at, at our present stage of development, to communicate waves to the ether by the oscillating discharge of condensers only extends over probably about 1 per cent. of the time available; in fact, that we only have a series of intermittent waves with long vacant spaces intervening. What we require is a better method of originating a continuous train of waves rather than these intermittent ones; and here we can formulate our problem, which may be solved by the mechanical engineer or probably by the electro-chemical engineer. None of us has as yet succeeded in constructing an alternator with a frequency approaching 1,000,000 per second; but who can say that recent developments in extremely high-speed turbo-generators of the De Laval type may not furnish us with a good start in obtaining such frequency by mechanical means? Again, turning to the possibilities within reach of the electro-chemist, very promising attempts have already been made by Lodge and others to produce electrical oscillations from condensers charged by a Cooper Hewitt mercury vapour lamp. Duddell has shown by his investigation of the singing arc that herein lies a method of producing a continuous series of discharges, although in this case the frequency obtained is not sufficient for our purpose. At any rate, the solution of this problem of continuous operation by means of Hertzian waves appears to be extremely hopeful, and, at any rate, it is one of first importance."

Passing to problems more directly within the field of the engineer, one of the broad group of questions with which nearly every class of electrical machinery is concerned is what Col. Crompton calls the problem of "core and coil." In considering this it is interesting to note the analogy to steam engineering, the electromagnet bearing the same relation to electrical machinery as the cylinder, piston, and crank do to the steam engine. Wherever we wish to translate mechanical into electrical energy, or electrical back into mechanical energy we are compelled to use the "core and coil."

So far as the core is concerned, the problems connected with its construction have developed with its use. The early cores were made of the best quality of pure forged iron, but for commercial reasons it became necessary to employ a material which could be cast into the required shapes. After preliminary experience with cast iron the advantages of steel castings became apparent, but with this have come the losses from hysteresis and from eddy currents, and the present core problems are mainly concerned with the efforts to minimise these effects. The addition of silicon, suggested by Barrett, has been found to improve the homogeneity of the material, but further improvements are to be desired. The present requirements may be formulated as follows.

"Maximum of homogeneity, permeability, low hysteretic coefficient, high resistance as a mass to eddy currents; of course, all these combined with sufficient mechanical strength to resist the mechanical stresses due to centrifugal forces when the core forms part of the revolving mass, or to the stresses set up by magnetic attraction when the core forms part of the frame of a stator or magnetic ring of large dimensions. In the other class of cores, particularly those subjected to alternating electrical stresses, such as the cores of transformers, we cannot hope to obtain sufficient freedom from the losses due to eddy currents by means other than minute subdivision—that is to say, by lamination, or in some cases by forming the cores of a bundle of individual wires. Great progress has been made in the production of such laminated material, and a great part of our constructive work lies in the organisation of the labour necessary to fit together the large number of sheets or stampings which go to form this class of

cores. Where such cores are used for revolving armatures, we meet with the secondary problem of securing satisfactory balance of the rotating mass, and it is not easy to obtain this, as any turning or cutting process applied to the edges of the thin sheets has a tendency to bring them into electrical conducting contact at the edges and ends, facilitating the eddy currents."

The coil which is wound about the core, has in like manner developed new requirements with progress in service. Thus, the early electro-magnets were made with coils formed of wire of round section wrapped with silk or cotton insulation, but this gives a mass of low conductivity, with entrapped air spaces, so that the escape of heat is difficult. Later attempts have included stepped windings, and windings with copper strip, but there is still room for much improvement, both in the preparation of the material for winding and in the insulation.

Another problem which is only partially solved is that of the electric storage battery. Col. Crompton is a believer in the great value of the accumulator even as it is now made, and he called attention to the marked improvements which have been made during the last fifteen years, especially in the reduction in cost of maintenance. At the present time the most economical equipment for small isolated plants for variable supply is a combination of an internal-combustion engine with suction gas producer, working for long hours and thereby charging storage sufficient to deal with the bulk of the load, but supplying the short hours of peak load from steam plant specially designed to work for short hours at a maximum efficiency. As for further improvement in the storage battery itself, Col. Crompton thinks that may lie along the line of standardisation, both in the batteries and in the means of charging them.

In regard to the great problem of electric traction on main-line railways, this is an entire department of engineering in itself. It is doubtless possible that higher speeds may be obtained with electric traction than are now common, but there is no reason to believe that these may not be met by correspondingly high speeds with steam locomotives of improved design.

The questions involved in the improvement of electric-lighting methods are touched upon in the lecture, as well as the problems connected with the improvement of electrical measuring instruments, and both of these fields offer abundant opportunities for effective work.

"A problem of real moment to both suppliers and users of electrical energy would be the discovery of a direct method of producing artificial cold by electrical means. If we had a ready means of producing artificial cold so as to obtain cold storage in our larders and so preserve our perishable foods, vegetables, and fruits, it would obviously greatly add to the pleasure of our lives and to the economy of our housekeeping. Of course, we can now produce artificial cold by connecting an air-compressor to be driven by an electric motor, and by expanding the air into the cold-storage chamber; but the method is costly and cumbrous. Probably something may be done by a well-designed high-speed air-compressor, but the real solution we are looking forward to is a direct method of producing cold from the electrical energy in our supply mains; and this probably is a problem for the electro-chemist, as we may conceive the apparatus taking the form of a battery abstracting heat from the surrounding air."

Broadly the work of the electrical engineer has been of profound influence in modifying other departments of engineering, and many of the improvements in prime movers, in workshop methods, and in all the departments of mechanical engineering especially, have been due to the requirements and demands originating in the development of electrical engineering.

"Finally, the greatest problem of all, and the one which will have the most profound influence on the well-being of our fellows, is the satisfactory development of our power schemes by which we hope to send the population back to the land. Power-distribution schemes of various degrees of magnitude have already been started in many countries. In those where water-power was available they have made considerable progress; but in this country, where we have to look to the generation of our power from fuel, the series of prob-

lems involved are of the highest interest, are extremely hopeful of speedy solution, and the social consequences that will follow on them are likely to be so important to the health and better development of our race that they deserve the most careful consideration of our best men.

"We already see that the necessity for bringing our working population into huge factories, so that they may work within the range of power allowed by revolving shafting, is already at an end; that nearly all power can be supplied through electric motors, and therefore the factory units themselves can be small, spaced more widely apart, and many classes of manufacturing processes can be carried out most perfectly in the worker's own home aided by the other members of his family.

"Already in Switzerland, France, and Germany trades are being profitably carried on under conditions very closely approaching those that have been foreshadowed to us by the promoters of garden cities. A large proportion of our workers can carry on their business at home in a workshop attached to the dwelling-house, and separated from the neighbour by the garden in which the children can grow up under the best conditions of light, air, and sunshine. The electrical engineer, who has been a chief cause in bringing about this vast social change, will be honoured among those who have really benefited mankind."

THE STABILITY OF MASONRY DAMS.

A REVIEW OF RECENT MATHEMATICAL THEORIES CONCERNING THE POSSIBLE WEAKNESSES OF EXISTING STRUCTURES.

Prof. W. C. Unwin—Engineering.

THERE has recently been some stir in engineering circles concerning the development of what has been termed some disregarded points in the stability of masonry dams, this interest having been largely created by reason of the application of a theory, developed about a year ago by Messrs. Atcherly and Pearson, to the great dam on the Nile at Assouan. Various editorial comments have appeared, notably in the pages of recent issues of recent issue of *Engineering* gives a valu- review of the accepted theory of the stability of dams, with some added methods of computation, by Professor Unwin, in a recent issue of *Engineering* gives a valuable résumé of the whole subject.

As a matter of fact, the subject was brought up by reason of the proposition to raise the height of the Assouan dam, and after a visit of inspection at the structure, Sir Benjamin Baker reported that it was inadvisable, for the present, at least, to proceed with the project of raising the dam 20 feet. It is said that Sir Benjamin Baker stated to Sir W. Garstin, that this recommendation was due in part to a consideration of the theory advanced by Messrs. Atcherly and Pearson, and however this may be, there has appeared in the technical press a sudden interest in the combined subject of a University College paper and the safety of the Assouan dam.

Without going into details of a highly mathematical treatment of the subject of stability of dams, it will be sufficient to state that the usual theory, as developed by Rankine and others, assumes but two ways in which failure may be expected: by sliding bodily off its foundation, or by overturning about some part near the toe, the separation taking place practically along a horizontal plane. It is also considered necessary that no tension should take place in the masonry of the structure, and this condition is fulfilled by observing the same rule as obtains in the proportioning of masonry arches, namely, by using such proportions as shall keep the line of resistance always within the middle third of the structure.

The investigations of Atcherly and Pearson, however, show that under certain circumstances the internal stresses may be such as to render rupture along a vertical line liable before failure by horizontal separation could occur, and the factor of safety against failure by vertical rupture appears to be only one-half to two-thirds that which has been taken as existing against horizontal rupture.

In examining this paper of Messrs.

Atcherly and Pearson, Professor Unwin calls attention to the fact that the distribution of stress on horizontal sections appears to have been merely assumed by the authors. As Professor Unwin says: "It is attempted to be shown that the really dangerous sections are vertical sections, and that on vertical sections of existing dams an alarming amount of tension exists."

Thus Messrs. Atcherly and Pearson say: "Whether we judge by the line of resistance lying outside of the middle third, or by the existence of serious tensile stresses, or by the magnitude of the mean shearing stresses, the vertical sections are critical for the stability in a far higher degree than the horizontal sections." Again quoting Professor Unwin: "It would be a very serious thing if these conclusions were true."

That they are true, Professor Unwin seems to doubt, and at the same time he admits that the ordinary theory of masonry dams is incomplete, because no attempt is made to determine the distribution of the shear on the horizontal sections. This distribution has not been attended to by the French engineers, and is not satisfied in some of the earlier French dams, and in a paper on the failure of the Bouzey dam, at Epinal, Professor Unwin himself showed several years ago, that there were reasons for regarding tension on horizontal sections as especially dangerous.

"All theories of dams must proceed on the assumption that the dam is a homogeneous elastic solid. As a matter of fact, dams are so constructed of rubble masonry, with strong cement mortar, that they are practically monoliths. They have no plane joints, and there is no reason for supposing that they cannot withstand a reasonable amount of tension in any direction in the mass. But it probably is desirable that there should not be tension on horizontal sections, at any rate on the water face. If any progress is to be made in the theory of dams, it must be by finding a method of determining the distribution of the shearing stress on horizontal sections."

Professor Unwin himself has devised a semi-graphical method of determining this distribution of shearing stress, and this he discusses briefly in his paper. The method of computing the compression and tension stresses generally adopted is briefly reviewed by Professor Unwin, and he sees no reason to doubt the correctness of the determination hitherto adopted for such structures.

Extending the computation to the shear on any horizontal section he shows how its distribution may be determined for vertical sections at any points upon the selected horizontal, the diagram which he constructs giving a complete knowledge of the stresses at any point. Without a direct comparison of Professor Unwin's determination with that of Mr. Atcherly no statement can be made as to the relative merits of the two methods. It is believed, however, that Mr. Atcherly assumes a very different distribution of the shearing stress from that shown by Professor Unwin to exist, and upon this distribution the whole computation is necessarily based.

The horizontal section considered by Professor Union is specifically stated by him not to be the base of the dam. Theoretically, the stresses would be greatest on the base of the dam, and it is this section which is chiefly considered in designing dams. But at the base there is a sudden discontinuity of form, such that renders the problem of exactly determining the stresses there beyond the power of mathematics. The effect of the rock into which the dam is built must be to reduce the variation of stress which would otherwise exist. For the engineer's purpose the calculated stresses will be in excess of the real stresses.

This discussion by Professor Unwin may well be permitted to offset that of Messrs. Atcherly and Pearson, at least until both methods have been submitted to experimental investigation, and there is little doubt that the result of the discussion will be the reopening of the whole subject in a manner which will enable the theory of dams to be placed upon a sounder working basis than has hitherto been the case.

One result of the discussion would appear to be a demonstration of the desirability of replacing simple masonry construction for dams by some system better adapted to the conditions which have to be met. There is little doubt that the methods of reinforced concrete, providing for tension stresses in a scientific and rational manner, permit the construction of arches, dams, and other structures far more cheaply, and

more satisfactorily than the older methods of pure masonry. In view of the fact that a system containing within itself the ability to resist tension, as well as compression and shearing, is available everywhere, at lower cost than the older imperfect method, it would seem that the better plan would be, not to try to discover how defective the older system is, but rather to emphasise the importance of using the modern system wherever possible. It is more than probable that the present discussion will assume an importance merely academic, after it has well done its work by showing how pure masonry should be abandoned altogether, and by convincing engineers and builders everywhere of the fact that reinforced concrete should become the standard method of construction for important structures of this character.

SPACE CONTROL OF MECHANISM.

METHODS OF APPLYING THE PRINCIPLES OF SPACE TELEGRAPHY TO THE CONTROL OF MECHANISM AT A DISTANCE.

Edouard Branly—Comptes Rendus de l'Académie des Sciences.

UP to the present time the practical applications of the transmission of energy have been developed almost entirely with a view of enabling telegraphic communication to be effected across space without the use of a metallic conductor, and the various systems of space telegraphy have attracted much attention. In a paper recently presented before the French Academy by M. Edouard Branly, himself well known as the inventor of the coherer, some additional applications of the principle are discussed, and from the account of his experiments in a recent issue of the *Comptes Rendus* some of his results are here given.

As. M. Branly remarks, the application of the inductive effects of electric discharges to the transmission of intelligence is the simplest use of the phenomenon, since this involves merely a repetition of the ame movement, the attraction of an electro-magnet, at such time intervals as will permit the distinction of signals. He has therefore attempted to devise an apparatus by means of which a series of events in a pre-arranged system may be effected, the order of action being under control of the distant operator, without requiring the presence of any operator at the receiving station. This idea permits the arrangement of an apparatus for controlling operative mechanisms upon abandoned fortifications, floating hulks, unmanned outposts, and similar situations.

The apparatus which M. Branly has constructed for experimental purposes in his laboratory is arranged to produce three different effects, the starting and stopping of an electric motor, the turning on and off of a system of incandescent lamps, and the effecting of an explosion, any of these effects being produced in any desired order by the distant operator without requiring any metallic or other connection with the receiving station where the motor, lamps, and mine are situated. These especial actions have been chosen arbitrarily for the purpose of demonstration, but it is obvious that a device which can control a group of such effects may readily be adapted to other purposes.

The principal feature which characterizes the apparatus of M. Branly is the construction of what he terms the distributor, by means of which the action of the distant discharge is localized at the receiving station. This distributor, in the case of the experimental apparatus constructed by M. Branly, consists of an insulated axis, carrying metallic discs in contact with brushes and springs for maintaining the passage of an electric current. The axis is maintained in rotation by clockwork, and each disc corresponds to a special function which is to be started and stopped.

Taking, as an example, the disc by which the control of the incandescent lamps is effected, this is arranged with a brush in continual contact with one of its sides. About one-fourth of the perimeter of the disc is of greater radius than the remainder, so that, as it rotates, this portion only comes into contact with a spring. When this contact is made a circuit is completed with a relay which turns on the lamps, but

this completion of the starting circuit can be effected only when the coherer forming a portion of the relay is affected by waves emitted from the starting station.

The other discs are similarly arranged to operate their respective circuits, the several discs being so placed on the axis that but one of them makes its spring contact at any one time.

In order that the operator at the transmitting station may be able to determine the control there is arranged a separate transmitter from the receiving station, which marks off on a moving tape before the operator's eyes lines corresponding to the contacts of the respective discs. It is therefore only necessary for the operator to cause a discharge when the proper contact appears before him on the tape in order to cause the lamps, the motor, or the mine to be operated. Thus, the interval between signals 1 and 2 marks the period when a spark from the transmitter will turn on the distant lamps, while the interval between signals 2 and 3 marks the period for starting or stopping the motor, and the interval between 3 and 1 shows the time for exploding the mine.

The various details have been carefully worked out by M. Branly, using his tripod-disc coherer, and employing special protective devices for the prevention of interference between the various discharges. As a piece of laboratory apparatus the arrangement has shown itself to be entirely practical, and there is no good reason why its action may not be extended to distances equal to those over which messages have been sent by the methods of magnetic wave space-telegraphy.

FREIGHT LOCOMOTIVE PERFORMANCE.

DATA AND RESULTS OF TRIALS OF A STANDARD FREIGHT LOCOMOTIVE ON THE ST. LOUIS TESTING PLANT.

Pennsylvania Railroad Company—Bulletin of Tests.

A LOCOMOTIVE is considered primarily as a machine for hauling trains, and many features in its design must necessarily be subordinated to its performance upon the road. At the same time the general principles of steam engine must apply to a locomotive as well as to a stationary engine, and hence it is of interest to compare the performance of a standard locomotive engine with other engines which are operated under more favorable circumstances. Until the use of stationary testing plants for locomotives became possible the comparison of locomotives and stationary engines was difficult, the conditions of road tests being such as to give results which were scarcely comparable with those obtained with machinery at rest. The development of the modern locomotive testing plant, from its small beginnings in Russia and at Purdue University, has now resulted in the systematic testing work conducted by the Pennsylvania Railroad Company upon the plant erected at the St. Louis exposition, and intended for continual service hereafter, and there is no good reason why any of the elements which go to make up the efficient performance of a steam locomotive should not be fully and accurately investigated.

In the bulletin recently issued by the Pennsylvania Railroad Company data and results are given of tests of a standard freight locomotive of the design known in the United States as the consolidation type, or in the international nomenclature as the 2-8-0 type, being the standard heavy locomotive used for freight service on the Pennsylvania system. This engine was of about 1,000 maximum indicated horse power, and was tested at speeds corresponding to about 7 to 25 miles an hour.

The detailed dimensions of the engine are given very fully in the report, but for purposes of discussion it will be of interest to give some of the principal data. Thus, the total heating surface of the boiler was 2,843 square feet, of which 166.4 square feet were in the fire box, and the grate surface was 49.2 square feet, giving a ratio of grate to heating surface of about 50 to 1, the boiler being designed to operate at a pressure of 205 pounds per square inch. The steam cylinders were 22 inches diameter by 28 inch stroke.

In the report of the trials the results are

very fully tabulated, and diagrams are plotted giving a graphical view of the results as curves, and from these some general conclusions of interest may be drawn.

The method of conducting a test, as outlined in the report, was such as to give confidence in the general reliability of the results, so that they may be considered as fairly comparable with test of stationary engines on record.

"Before the tests were begun, considerable time was spent in making analyses of coal in order to get a bituminous fuel having high fixed carbon, little ash, producing little smoke, and with as little tendency to clinker as possible. That finally accepted was furnished free of charge by the Berwind-White Coal Mining Company, from their Scalp Level mines near Johnstown, Pa. The coal was of very good quality but friable, and when the draft was strong a good deal of the fine portion was drawn through the tubes into the smoke-box. The heating value per pound of dry coal averaged more than 14,000 British thermal units.

"In preparation for a test, the locomotive was gradually worked up to the desired conditions and then run 10 or 15 minutes longer before observations for the recorded data were made. A warning signal of four bells was given five minutes before the test began, and 15 seconds before each reading a signal of two bells was sounded, one bell being sounded for the time of observation.

"Up to the time of starting, the coal and water used were taken from unweighed supplies. At the signal to start a box of weighed coal was dumped on the firing platform. The heights of water in the boiler and the feed water tank were then noted and thereafter all coal and water was carefully weighed. At the conclusion of the test the water levels were brought to the heights noted at the beginning of the test.

"After the last observation the log sheets were worked up by the observers and checked after which they were handed to the computers. As the readings were taken, the principal items were plotted on a graphical running log. Any irregularities or inconsistencies were hence immediately made known."

Considering first the boiler, the most noteworthy feature is the intensity of furnace action. The dry coal fired per square foot of grate area ranged from 22.7 pounds to 86.4 pounds, the firing reaching as high as 4,252 pounds per hour. The equivalent evaporation, from and at 212 degrees, ranged from 262 to 625 pounds of water per square foot of grate per hour, the maximum boiler horse power, computed on a basis of 34.5 pounds, being 891.3 h. p., this evaporation corresponding to 5.18 to 2.39 pounds per square foot of heating surface. The evaporative performance of the boiler naturally varied according to the rate at which it was forced, the evaporation ranging from 11.53 to 6.63 pounds of water per pound of dry coal. The former rate compares very favorably with carefully fired stationary boilers, while the latter is more nearly what has been considered the working performance of locomotive boilers. The efficiency of the boiler dropped off rapidly as the rate of evaporation increased, the range being between the rather wide limits of 78.93 per cent. and 45.37 per cent.

The performance of the engine naturally varied with the operative conditions. The speeds during the tests ranged from 40 to 160 revolutions per minute, corresponding to 6.7 to 26.6 miles per hour, with boiler pressures at about 200 pounds per square inch, and cut off from 22 per cent. for the slow speed to 42 per cent. for the maximum speed. The indicated power at the slow speed was 365 h. p. with a mean effective pressure of 85.7 pounds, and a consumption of 28.33 pounds of steam per i. h. p., the maximum indicated power being 1036 h. p. with a consumption of 23.74 pounds per i. h. p. The maximum dynamometer horse power, corresponding to the above maximum indicated power, was 848.6 h. p., this giving a mechanical efficiency of 82 per cent. for the machine, an excellent showing.

From the viewpoint of the railroad engineer one of the most important points in the performance of a locomotive is the pull on the draw-bar, since this, taken in connection with the effective horse power, determines the usefulness of the machine for hauling cars. The maximum recorded draw-bar pull during these tests was 22,078 pounds, taken at a speed of 80 revolutions, and a cut-off of 37 per cent., corresponding to a speed of 13.4 miles an hour, but

higher results might have been obtained had not operative difficulties with the brakes prevented.

Broadly, the result of these tests is to give the locomotive a higher status as an efficient steam engine than it has hitherto held. The conditions which limit the grate area of the locomotive boiler in proportion to the amount of fuel to be burned, and the consequent intensity of combustion, have never appeared favorable to high boiler efficiency, while the absence of independent cut-off gear, and the limitations of the link motion as a regulator of the expansion ratio have also been held unfavorable to best engine performance. Under these structural disadvantages, however, we have results which compare most favorably, both as to boiler and engine, with stationary engines of similar size and speed operating under favorable conditions.

One of the arguments in favor of the application of electric driving to main-line traction has been the superior efficiency of the steam engines and boilers which it is possible to place in the stationary power house over that of the steam locomotive, but when conversion and transmission losses are taken into account it appears that there would be little or no gain in the cost of power at the draw-bar with such locomotive efficiencies as these tests show.

It is only by such exhaustive and scientific investigations that any reliable criterion of performance can be had, and there is little doubt that further tests of locomotives will go far toward furnishing data upon which some of the important questions concerning railway motive power are to be decided.

RAILWAY CAR CONSTRUCTION.

SCIENTIFIC PRINCIPLES APPLIED TO THE DESIGN AND CONSTRUCTION OF THE FRAMING OF PASSENGER AND FREIGHT CARS.

C. A. Seley—Purdue University.

IT is now generally recognized that the effective train-mile capacity of a transportation system, upon which the most advantageous ton-mile rates can be made, depends largely upon the carrying capacity of the cars. For this reason everything which leads to better car construction is of importance both to the railroad man and to the shipper, as tending to higher efficiency in transport.

In a paper recently read at Purdue University by Mr. C. A. Seley, mechanical engineer of the Chicago, Rock Island & Pacific Railway, upon the subject of the framing of passenger and freight cars, some excellent suggestions are brought out in connection with the increase in efficiency of this important element in the mechanism of transportation, and some of the more important points in this paper are here reviewed.

After briefly reviewing the development of the modern car from the early attempts down to modern times, Mr. Seley proceeds to examine especially the development of the modern freight car.

"Our earliest freight cars were 10, 12 and 15 tons capacity and it was not until about 1880 that 20-ton cars were common. Prior to that date the Master Car Builders' Association had been organized and one of their principal aims was to standardize car details so as to facilitate the interchange of cars, that loads could be carried unbroken by connecting lines. The work of that Association has been of the utmost value to the railroads and the public and very many common standards have been adopted, so that wherever a car may stray, the essential parts which have to be maintained in service can be applied without having to send to the owning road for repair parts as was the custom in the early days.

"This standardizing has been of great influence in shaping the designs of the later cars of higher capacity. The last ten years have been remarkable in the history of freight car development. Cars of 40 tons capacity were soon followed by those of 50 tons, and while the latter capacity has been exceeded in a few cases and for special purposes the 50-ton car seems to us to be about the limit. There are two principal reasons for this. One is the concentrated weight on the adjacent trucks of

two 50-ton cars coupled being as great as a very heavy engine load. Freight cars are generally allowed ten per cent. excess lading over their marked capacity, and this amounts on a 50-ton car to a total of 110,000 pounds. Adding 40,000 pounds for the dead weight makes a total of 150,000 pounds. There are many consolidation engines that do not exceed the above weight on their eight drivers, yet the common cast iron wheels used under these cars carry as much weight as many an engine driver, and when concentrated on a short span give an equally heavy load. The second reason is that cast iron wheels seem to have about reached their safe limit of their strength in carrying 50-ton cars.

"The vital point in the cast iron wheel is the flange. We cannot thicken it or add supports on account of being restricted by necessary clearance in frogs and crossings. The braking power of 50-ton cars is high and on long grades the wheels become highly heated and then cooled perhaps suddenly. The consequent expansions and contractions may develop fine cracks at the root of the flange and in time weaken the flange. These cracks close and are almost invisible when the wheels are cold and thus escape detection. They are very much in evidence, however, when a piece of the flange drops off in going through a frog or on a heavy curve. This development has caused much concern to the railways and as much as anything else has stopped a further increase in capacity of general service cars."

In considering the framing of freight cars as at present constructed, Mr. Seley calls attention to the fact that the principal elements in the carrying strength are the truss rods by which the sills are reinforced. These are often unsuitably proportioned and spaced, and much better results would be obtained if the distribution of the forces was analyzed mathematically. It is possible, however, to take advantage of some hitherto neglected features in freight-car construction and obtain what should be a better and stronger design without materially increasing cost or weight.

"Let us examine the side framing of an ordinary box or furniture car. Beginning at the bolster ends which are the foundations or abutments we find the foot of a diagonal brace which extends outward to support the end of the car. There is also the foot of a vertical post and a framing rod, and then the foot of another diagonal brace inclined towards the center of the car, meeting a vertical post at the plate. We will probably find two or three such diagonal braces and intermediate posts between the bolster and the door posts, and it would seem as though we have all of the elements of a Burr 5-panel truss, the plate and sill being the top and bottom chords and the posts and braces being the vertical and diagonal ties. Now, if such trusses are commonly used in bridge construction and without a set of under trussing, why should the strength of such a construction be entirely neglected and the load carrying be put entirely on the lower framing in car construction? If you will look up your books on such trusses you will note in the diagrams the use of a pair of diagonals in the center panel. In a box car we require the center panel to be left clear for a doorway, but your books go on to state that if the lading is symmetrical the center diagonals have no load and could be omitted. The ordinary lading of cars, when to full capacity, is generally symmetrical or so nearly so that we can afford to neglect the center diagonals and trust to sills and plates taking cars of what little shear there may be from an occasional unsymmetrical load."

The question of all-steel cars naturally suggests itself in this connection, and since the introduction in 1897 of large-capacity steel cars for carrying coal and ore these have been much discussed. The 50-ton self-clearing hopper cars used for carrying coal and iron ore have come into extensive use because of the high percentage of revenue load carried by them. What is meant by the percentage of revenue load may be illustrated as follows: Wooden cars of 44,000 lbs. capacity average about 22,000 lbs. dead weight, a total of 66,000 lbs., of which 66 per cent. is revenue load. Fifty-ton cars carrying 11,000 lbs., weighing 38,000 lbs., carry over 74 per cent revenue load. In the former case, there are 2 lbs. of live load to one of dead, and with the fifty-ton car nearly 3 to 1. A comparison shows that 2½ times the load is carried with but 1.75 times the dead weight.

These advantages, however, appear only when the cars are run fully loaded, and this condition cannot always be fulfilled. Experience has shown that for general purposes the limiting useful capacity of box cars is about 40 tons.

Mr. Seley goes into the application of the truss system to cars somewhat in detail, especially as connected with the use of steel side framing, and the fact that more than 10,000 cars have been built on this principle and operated with satisfactory results is a strong verification of the correctness of the method.

The importance of directing the best engineering ability available to the question of car construction will be emphasised when it is realised that the cost of the freight-car equipment of a railroad ranges between three and four times that of the locomotives, and Mr. Seley's paper itself forms an important argument for the value of the application of scientific principles to this department of railway engineering.

HIGH-SPEED RAILWAY TRAINS.

A COMPARATIVE STUDY OF THE FASTEST REGULAR TRAINS ON EUROPEAN AND AMERICAN RAILWAYS.

Arnold Kramer—Glasers Annalen.

IT is not easy to compare the performance of high-speed trains in different countries, or even in different parts of the same country, simply because the question contains too many variables. The character and weight of train, the grades and curves of the roads, the nature of crossings and systems of signalling, and numerous operative details enter into the problem of train speed, and in the desire to make a good showing for their roads the respective advocates find ample opportunity for arrangement of the reports and records to support their contentions. It is, therefore, interesting to note a paper in a recent issue of *Glasers Annalen* by Mr. Arnold Kramer in which a comparison of a number of high-speed trains is made based entirely upon the running schedules, and freed from any attempt to advocate the performance of any particular road, the facts being considered entirely from an outside viewpoint.

Leaving out of consideration the speeds made upon the Marienfelde-Zossen railroad as experimental, and taking the data from the operative schedules for 1903, Mr. Kramer gives some interesting comparative figures. Germany does not appear at all in the comparison, and Mr. Kramer explains that this is due both to the fact that the lighter permanent way of the German railways does not permit the safe attainment of maximum speeds, and also because the increased cost of high speeds does not appeal to the management. It may be remembered that the first experiments on the Marienfelde-Zossen line showed that the limits of speed were due to the condition of the track, and that the highest speeds were not attained until the entire line had been re-laid with much heavier rails than had been originally thought necessary.

The fastest train in Europe is operated by the Northern Railway of France, on the line between Paris and Calais, the train being drawn by a De Glehn four-cylinder compound locomotive, a photograph of this train being shown on page 968 of the September issue of this Magazine for 1904. The distance between Paris and Calais is 184.73 miles, and this is covered by the express trains in 3 hours and 1 minute, including a stop of 4 minutes at Amiens for water. The run from Paris to Amiens is made at a speed of 63.2 miles per hour, and from Amiens to Calais at 59.7 miles per hour. It is intended to place track tanks on this line to enable water to be taken up while running, and this will enable the stop at Amiens to be avoided.

Mr. Kramer admits that the fastest train in the world in regular service is the Atlantic City Flyer of the Philadelphia and Reading Railway, this train making the run of 55.5 miles between Camden and Atlantic City at a rate of 67.96 miles per hour. This train is closely pressed by the Pennsylvania Railroad between the same points, its distance of 58 miles being made at the rate of 66.92 miles per hour. The weights

of the trains average about 200 tons, and upon special occasions the Reading trains have made the distance of 55.5 miles in 46.5 minutes, corresponding to a speed of 71.6 miles per hour, while a portion of 35 miles of the run has been made at the rate of 81.5 miles per hour.

The fastest train in the world for a distance of more than 300 miles is the Empire State Express of the New York Central and Hudson River Railroad, this making the distance of 439.52 miles from New York to Buffalo in 8 hours and 15 minutes, a speed of 53.3 miles per hour. This is closely followed by some of the long-distance trains in Great Britain, the distance of 393 miles from London to Edinburgh, by way of the Great Northern Railway, being made in 8 hours 15 minutes, a rate of 53.3 miles per hour, while the 401 miles from Euston to Glasgow, by the London and Northwestern Railway, is covered in 8 hours, a speed of 50.1 miles per hour.

Returning to the Continent, we have the Sud-Express of the Paris, Lyons and Mediterranean Railway, making the run of 486.25 miles from Paris to Bayonne in 9 hours 43 minutes, a speed of 50 miles per hour, while it is proposed to operate on the same line a through train from Paris to Nice, a distance of 674.4 miles, in 13 hours 30 minutes, this giving also a speed of 50 miles per hour, maintained for a longer run than has been attempted anywhere.

Mr. Kramer tabulates a number of the high-speed trains of Great Britain and the United States, for which reference must be made to his original paper, but some general deductions may be made from the tables. Thus in England the average speeds on runs of 50 to 200 miles in length ranges from 55 to 61.7 miles per hour, the most notable of these being the run from Paddington to Exeter, on the Great Western Railway, 193 miles at 55.3 miles per hour. About 55 miles per hour appears to be the running speed of a number of British express trains.

In the United States the rate naturally falls off for the longer distances and as the first-class road-beds of the great trunk roads are passed. The Twentieth Century Limited, of the New York Central, makes the run from New York to Chicago, a distance of 979.5 miles, at a rate of 49 miles per hour. From Chicago to San Francisco, a distance of 2,314.90 miles, by way of the Chicago and Northwestern Railroad and the Union Pacific Railroad, an average speed of 33.58 miles per hour is made, including 44 stops, while by the Santa Fé route, a distance of 2,569 miles, the average speed is 33.75 miles per hour. It must be remembered that these are average speeds over much difficult country, involving heavy grades and many curves, and that much higher local speeds must be made over long stretches in order to maintain this average for the entire distance between Chicago and San Francisco.

As Mr. Kramer states, there is a constant and gradual tendency to increase and maintain higher speeds, and with the improvements in permanent way, the introduction of balanced compound locomotives, and the increase in traffic, the standard of speed may be expected to advance. It is too soon to predict the effect of the introduction of electric traction upon main-line speeds, but the trials of the electric locomotives which have been made for the New York Central system show that if higher speeds are demanded they can be furnished as well by electricity as by independent steam locomotives.

With all this striving for increased speeds in railway travel it must not be forgotten that it is actual economy in time between terminals which really counts, rather than spurts of greater or less duration upon the route. It is of small value to gain a few minutes on the road, to waste several times the gain while waiting in the terminal yard or standing in a ferry slip, and that road which gives the highest speed service to its patrons is the one which carries them in the shortest time from platform to platform of its terminals, and not the one which can only point with pride to a record run for a portion of the distance. That this fact is appreciated is shown by the great expenses which are being incurred in the large terminal cities to avoid grade crossings and other occasions for slowing down in approaches, and there is at present much greater opportunity for gaining time by just such radical work than is apparent by forcing higher train speeds upon the road.

STEAM-TURBINE CONSTRUCTION.

PRACTICAL EXPERIENCE WITH THE MECHANICAL CONSTRUCTION OF STEAM TURBINES AND TURBO-GENERATORS.

W. J. A. London—Institution of Electrical Engineers.

NOTWITHSTANDING the attention which has been given to steam-turbine design from the thermo-dynamic standpoint, there has been little published relating to the mechanical features which are necessarily involved in the building of machines differing so widely in form and operation from the ordinary steam engine. For this reason the paper of Mr. W. J. A. London, presented before the Manchester section of the Institution of Electrical Engineers is of interest, dealing as it does with structural details, not only of the steam turbine, but also of the special forms of electrical generators adapted for direct-connection to motors of such high rotative speeds.

Speaking first of the features of the horizontal and the vertical designs of steam turbines, Mr. London says:

"Steam turbines are now constructed with vertical and horizontal shafts. The vertical turbine naturally appeals to the engineer at first sight as being the most suitable for high speed, there being no sagging in the shaft (due to its own weight between the bearings). The further claim is made for the vertical engine that it takes up less floor space than does the horizontal design, this saving meaning a lower cost of foundations and smaller engine room. The present designs of the vertical turbine, however, now on the market do not differ to any great extent in superficial floor area from that taken by one or two types of horizontal machines. Against the advantages set forth above of the vertical machine we must put the following disadvantages:—General inaccessibility, and the difficulty met with and time necessary for the withdrawing of, say, the turbine spindle to attend to any repairs that may be necessary. The footstep bearing necessary to support such a rapidly revolving heavy shaft calls for an exceptional design, and should the supporting fluid give out, considerable damage would be done. Auxiliary machinery is necessary for the supply of this supporting fluid, and also a relay connected to an emergency pump. This auxiliary machinery means additional plant to look after, and floor space which must be added to that taken up by the turbine. A further disadvantage of the vertical type is the fact that the heat radiated from the turbine cylinder rises up and heats the generator. The top bearing must be so designed that it is not possible for any oil to leak on to the generator, the effect of this being often very serious. The stuffing box between the turbine and the generator must also be absolutely steam tight, to prevent the possibility of any vapour rising into the generator. None of the above difficulties are met with when the machine is built on a horizontal axis."

Mr. London passes in rapid review the different forms of steam turbine, showing how the machines of the pure impulse type, in which the expansion practically all takes place in the stationary members present different structural problems from those obtaining in the so-called pressure turbines, in which the expansion occurs in the revolving as well as in the stationary blades. In the impulse machines, such as the De Laval, Rateau, Zoelly, Curtis, etc., there is little or no difference in pressure between the two sides of the wheel, so that there is no great tendency for the steam to leak past the periphery of the wheel and in consequence fine radial clearances between the wheel and the casing are not needed. In such machines, even of the multiple type, the distance between shaft bearings is comparatively short, and possible troubles from bending or whipping are correspondingly reduced.

In the Parsons and Westinghouse turbines a totally different general construction from that of the impulse machine is required. A spindle of a Parsons turbine consists usually of a cast-steel drum having forged steel ends shrunk or pressed into it. This form of spindle is much stiffer than a thorough-going shaft with disks, but a certain amount of whipping may take place, owing to its overall length.

"With the Rateau, Zoelly, or Curtis machines, the steam can be concentrated and passed through only a portion of the periphery; but in consequence of the difference of pressure existing between the two sides of the rotating vanes in a Parsons turbine, the whole annulus must be filled with steam, so that small diameters and low velocities have to be resorted to where its density is very high, in order that the percentage of clearance to blade height may not be excessive. As the steam expands, its volume increases, and as the number of rows or blades varies with the square of the velocity, it is advantageous to step up in the diameter of the spindle as soon as possible."

In some of the more recent Westinghouse turbines the machine is made double-flow, steam being admitted in the centre, passing through equal rows of blades on each side, end thrust thus being eliminated. By adopting a combined impulse wheel to take care of the expansion from boiler to about 60 pounds absolute it is found that the velocity required permits such dimensions that the Parsons blading can be successfully used on the one diameter. Such a mixed turbine can be made much shorter than the original Parsons type, while maintaining the same high degree of efficiency.

The high rotative speeds met in steam-turbine work naturally renders the bearings and journals different from those developed in the experience with slow-running steam engines. The demand for stiffness involves the use of shafts and journals of large diameter with bearings of ample length to keep down the unit pressure. Large diameters, however, mean high circumferential speeds, increasing the work of friction, while there are limitations to the effective length of bearings.

"The effect of clearance has a marked influence on the efficient working of turbine bearings. In consequence, it is better to ease the bearings considerably on the upper half; this materially decreases the friction, and allows much smoother running. If the shaft is well balanced, the upper half of the bearing can be entirely dispensed with, and this is practically done in many instances, a clearance of 1/16 in. being allowed on the top half of the bearings. However, instead of cutting the whole of the top of the bearing away, it is safer to allow a strip of the bearing to remain along the top, thus holding the whole shaft.

"The peripheral velocity in turbine bearings is necessarily very considerably higher than in ordinary steam engine practice, velocities of 50 ft. per second being regular practice. The load per square inch, however, must be kept very low. In steam turbine practice to-day it is usual to allow a constant of 2,500 for the peripheral velocity in feet per second multiplied by the pressure per square inch on the bearings. This in some cases is raised as high as 3,000. The crux of the whole question is the facility for dissipating the heat, and for this reason as much of the bearings as possible should be in contact with the outer walls, provided, of course, that the outer walls themselves are also free to dissipate heat. Water-cooled bearings are very often resorted to in very large machines, the principal advantage of these being that in a turbine of the Parsons type the water-cooled bearing isolates the heat of the high pressure end of the turbine from the bearing proper. In machines where there is no close contact with steam-heated surfaces, bearings working within the limits mentioned can be run satisfactorily without water cooling. An ample oil supply, however, should be given. The oil leaves the bearings uncontaminated by water or other matter, and can be returned to the cistern and re-used. The usual European practice in turbine work is to allow about .05 gallon per square inch of bearing surface per minute."

The high rotative speeds of steam turbines has naturally demanded corresponding modifications in dynamo construction. Both for continuous and for alternating current machines the centrifugal forces demand modification in construction. The majority of continuous current machines are constructed wth semi-enclosed slots, a key-piece being driven in on top of the conductors to hold them in position. Bronze end bells have been employed to hold the end windings, but even this material must be employed with care to secure sufficient strength.

The larger alternators are made with rotating fields and stationary armatures, and

in such designs it has been found advisable to make the rotors of solid steel forgings, the centre being bored out to admit the high-carbon steel shaft, the sides being milled out to admit the windings, ventilating ducts being also milled out.

"As in continuous current work, special care must be taken with the winding of the rotors so that the possibility of the shifting of the conductors is reduced to a minimum; and further, owing to the great weight of these rotating fields, the shafts should be as stiff as possible to prevent whipping, which point to another advantage of the solid pole construction, as it materially stiffens the shaft.

"In turbo-alternators, while the core and copper losses are slightly smaller than those of the slow-speed type, it is much more difficult to dissipate the heat on account of the much smaller radiating surface. To reduce as low as possible the loss by windage, smooth cores should be adopted where possible. In order to obtain ventilation two methods may be adopted:—

"1. As much exposed surface and free airway as possible.

"2. Machines entirely enclosed, with forced ventilation.

"Both these systems are now extensively used, and it is hard to decide which is preferable. The first has the advantage of being more efficient, but has the objection of being noisy. This noise is almost entirely eliminated in the enclosed machine, but tests have shown that with this type, to obtain sufficient ventilation, a considerable amount of power is absorbed by the blowers, resulting in a somewhat less efficient machine."

Mr. London discusses the problems involved in balancing, but these are not greatly different from those already experienced in high-speed woodworking machinery, and both in theory and practice they are well understood.

THE STRENGTH OF BOILER FURNACES.

PRINCIPLES OF DESIGN AND CONSTRUCTION OF INTERNALLY-FIRED BOILER FURNACES FOR THE MAINTENANCE OF MAXIMUM EFFICIENCY.

D. B. Morison—North-East Coast Institution of Shipbuilders.

INTERNALLY - FIRED boilers are among the oldest forms which have been used for the generation of steam, and with modern improvements they are still very extensively used, especially in marine service.

In the early Cornish and Lancashire boilers the furnaces, in which the grates are placed, in which the highest temperatures are produced, and from the surfaces of which the greater proportion of the steam is generated, were made in the form of plain cylindrical tubes straight in longitudinal section throughout their length. Such furnaces could be operated only at moderate pressures, owing to the danger of collapse by external pressure, and hence the demand for higher pressures led to various methods of strengthening the weak construction. Since it was early shown that a long tube offered less resistance to collapsing than a short one it was suggested that the addition of circumferential reinforcements to a flue at intervals would effect the result of converting it into a succession of short flues, with corresponding increase in strength, and from this idea may be said to have developed the modern types of corrugated and suspension furnaces in general and successful service.

In a paper presented recently before the North-East Institution of Engineers and Shipbuilders by Mr. D. B. Morison, the development of the modern furnace is discussed and some of the operative conditions affecting its strength are examined in a very practical manner.

"The strength value of a furnace can be estimated only by its behaviour when in use in a boiler under severe conditions of work. If the wall of a furnace were always clean and a good conductor of heat, so that the temperature of the metal never largely exceeded the temperature of the boiler steam, then the furnace would never deform, because in that condition it would be capable of withstanding (according to Board of Trade regulations) about five times the load which could ever be imposed upon it by the steam pressure.

Therefore, a furnace deforms or collapses only when a portion of its wall becomes so overheated as to reduce the strength of the metal by an amount which renders it incapable of resisting the pressure to which it is subjected, and it follows that the safety of a furnace does not depend so much upon the strength theoretically derivable from any particular form of tube, as upon the ability of that form to minimise the possibility of local overheating, and to safely withstand the weakening effect of overheating, should it by any chance occur. It is consequently possible for a tube to be of great strength when subjected to cold water external pressure, and yet be practically a failure as a furnace in a boiler."

The early methods of reinforcing furnaces by the use of stiffening rings and the like were effective in eliminating the longitudinal weakness, but they introduced new difficulties which had in turn to be met.

"Deformation involves definite mechanical movement, and this, of course, cannot take place at any point without either fracturing, extending, or compressing the metal in the immediate vicinity, and it is the resistance of the adjacent material to this fracture, extension, or compression that reinforces the material at the point where the localised stress has become most severe. If a cylinder be provided with stiffening rings, it is evident that these rings will not be deformed under a stress which is quite sufficient to collapse the intervening metal, so that they constitute fixed points of support, between which deformation of the cylindrical form can only take place by the extension of the metal. No deformation can take place between the stiffening rings which does not impose a bending stress upon some portion of the intervening metal, and the shorter the distance between these points of support, the stronger will be the longitudinal section, considered as a beam."

It soon became evident that the reinforcement, to be free from disturbing influences, should be formed in the material of the furnace, and Mr. Morison traces the development of such improved furnaces, from the strengthening rings of the Purves furnace, through the great improvement of the Fox corrugated furnace, to the suspension type of furnace, in its earlier and later improved forms. The term "suspension" as applied to furnaces of this class is shown to describe the action correctly, since the ridges, being the stiffer and cooler portions, act to sustain the valleys. The strength-controlling elements of the structure are the ridges, and until they yield the furnace cannot collapse.

"A furnace is often very severely strained and is liable to slight deformation if the tubes are too close to the crown or if the furnace is otherwise too rigidly stayed. A furnace is subjected to very great variations of temperature, and is consequently always tending to lengthen or shorten, so that, if by faulty design it is not allowed breathing facilities, it will either leak at the landings or alter its shape. Furnace firebars should not be fitted in tightly when cold, for obvious reasons. Assuming that attention is given to these points, and that shortness of water does not occur, a furnace collapses only when its wall becomes heated to redness through either oily deposit or excessive scale, so that the safest furnace is the one which will longest withstand the conditions of severe usage before the metal in any portion of its wall becomes weakened through overheating, and which having become overheated will retain its shape for the longest period of time before collapsing. If a furnace of any recognised type is covered with water and is reasonably clean, it will never collapse, as in that condition its resistance is five times greater than the load brought upon it by the steam pressure, but this margin commences to disappear when the temperature of the metal reaches 650° F., and vanishes when the metal becomes red hot."

Since furnaces are readily made of ample strength to resist ordinary working stresses it is evident that the real capacity of a furnace to resist collapse becomes apparent only when it is exposed to extreme heat. As we have said temperature at which steel begins to lose its strength appreciably is about 650° F., and at 1,200° F. about 75 per cent. of the strength has disappeared. The lower of these temperatures is never reached by steam at any working pressure, since the temperature of steam at 200 pounds pressure is only about 380° F., hence all that is necessary is to keep the surfaces clean in order to avoid overheating.

It is not necessary that a thick deposit of oily matter should form upon the furnace to cause the temperature to rise, since a mere coating of oil, of inappreciable thickness, is sufficient to check the protective action of the water and permit the temperature of the metal to rise about the weakening point. Mr. Morison cites an example in which the use of an inferior quality of oil for swabbing the engine rods and for lubricating the auxiliary engines caused a serious collapse. The oil, becoming emulsified with the feed water, and being therefore unfilterable, passed into the boilers forming a deposit on the furnaces.

"When oil is fed into a cylinder, it should not only be unaffected by the temperature, but should distribute itself amongst the steam in such a manner as to effectively lubricate the surfaces with which it comes in contact. If, on the other hand, the oil is so sluggish as not to associate with the steam, it is either local in its action, or it is blown through the engine practically unused. Cylinder oil should therefore possess the greatest fluidity consistent with the conditions and requirements prevailing, and yet have sufficient viscosity to perform its lubricating functions on the parts to which it attaches itself and which, in the case of cylinders, are always more or less wet. In order to increase the lubricity of pure mineral oil, and to assist it to adhere to the cylinder surfaces, some manufacturers add a very small percentage of saponifying oils; but for very high temperatures, and especially for superheated steam, it is very questionable whether a straight high-grade oil is not the safer to adopt. Other essentials for a good cylinder oil are that it shall not carbonise or gum, and that it shall be entirely free from acid. The demands are most exacting, and can only be met by a mineral oil of the highest grade.

"Steam from auxiliary engines, steering engines, winches, or other deck machinery, should not be discharged into a main condenser direct, but into an auxiliary condenser, and then only after the oil has been separated from it. Such precautions, as I have indicated, constitute a necessary standard of engineering practice, if maximum commercial success is to be attained, as only by their strict observance can the efficiency of the heating surface of the boilers be maintained, and the risk of furnace accidents reduced to a minimum."

THE EFFICIENCY OF GAS ENGINES.

A SYMPOSIUM UPON THE MECHANICAL EFFICIENCY AND THE INDICATED CAPACITY OF INTERNAL COMBUSTION MOTORS.

Zeitschrift des Vereines Deutscher Ingenieure.

IN the course of investigations intended to aid in the establishment of standard methods of rating the performance of internal-combustion motors, the Verein Deutscher Ingenieure has recently published in its *Zeitschrift* a symposium of communications from a number of eminent engineers of experience in this line of work. Among the contributors to this valuable discussion we note the names of such men as Stodola, Riedler, Meyer, Schöttler, Ehrhardt, and Wagener, and the points brought out are of value and interest.

Professor Stodola points out that our notions of gross and net efficiency in gas engines are derived from similar terms in connection with steam engine practice, the net power being simply the gross indicated power less the frictional losses in the machine, and the mechanical efficiency being the ratio of the net to the gross power. He also refers to the so-called thermodynamic efficiency, this being the ratio of the work developed to that which would be obtained from the same quantity of heat supplied to an ideal machine working through a predetermined cycle. The ordinary idea of the thermal efficiency of a heat engine of any type is the ratio of the heat equivalent of the work developed to the total amount of heat supplied in the fuel.

In the practical application of these values, however, various opportunities for differences in opinion and practice occur. Thus, in the case of the steam engine there are other losses besides the friction of the

mechanical parts, and among these Professor Stodola calls attention to the loss by throttling the exhaust, and to the leakage losses. In the case of the condensing steam engine the question also arises as to the deduction of the resistance, frictional and otherwise, of the air-pump, especially when this is driven independently, either by steam or electricity. In the case of the two-cycle gas engine there is also the resistance of the compression pump to be taken into account, and comparable results cannot be expected unless these points are consistently treated. It is a question whether the actual resistance in the compression pump should not be separated from its frictional resistance, and Professor Stodola maintains that the air pump should be indicated as well as the working cylinder, and that the difference between the power indicated in the cylinder and the resistance indicated in the air pump be taken as the true indicated power. In this position he is supported by the precedent of Professor Schröter in his tests of the Diesel motor, and by Mr. Dugald Clerk in his practice.

This point is of especial importance in the determination of the mechanical efficiency of the gas engine, since the ratio of the indicated power to the brake power will be very materially affected according as the indicated negative work on the air-pump is deducted or not.

Professor Riedler maintains that the indicated efficiency of a gas engine should be based upon the indicated power in the cylinder, regardless of the work to be overcome in the compression pump, and cites the similar practice in steam engineering, in which no deduction is made for air-pump resistance, the resistance of the air-pump being wholly included with the mechanical resistance of the engine. Professor Meyer differs in this respect, but very properly considers it a matter of minor importance, since the thermal efficiency of the gas engine should be based upon the brake horse power, as the only true measure of efficiency.

Professor Riedler calls attention to the fact that the resistance of a compression pump operating in connection with an internal-combustion motor is by no means analogous to that of an air-pump working in connection with a steam engine, the latter acting to reduce the back pressure in the power cylinder, while the former does not.

So far as the actual practice goes, it is a matter not so much for discussion as for unification, and it is most desirable that the system of reporting gas-engine tests should be standardized in such a manner as to render the results scientifically and practically comparable. It is of little use to state that such an engine has a thermal efficiency of 30 per cent., for example, if it is not known upon what basis the efficiency is computed, and of two such indefinite statements one cannot tell in any way which is the better machine.

In the codes of the American Society of Mechanical Engineers for testing steam and gas engines, the question of the resistance of the pumps is not stated to be deducted from the indicated power in determining the efficiency, although all the steam consumed by the auxiliaries is directed to be changed to the steam-consumption of the engine, this steam being measured separately, when possible, for convenience in analyzing the performance. In both steam and gas engines the power is stated to be either indicated or brake, but no hint is given as to whether the indicated power is simply the power indicated in the main cylinder, or whether it has had the air pump or compression pump resistance deducted.

As a matter of fact practice is contradictory in this respect. In steam-engine trials it has been customary to take the indicated power as simply that shown by the indicator in the cylinder, and to allow all other resistances to be included in the internal resistances of the engine, and deducted by the operation of measuring the brake horse power. This practice undoubtedly acts to give a higher thermal efficiency and a lower mechanical efficiency than would be the case if the indicated negative work in the pump were deducted from the indicated power before making the computation. In the case of internal-combustion motors it appears to have been the practice to deduct the work done in the compression pump, and Professor Meyer calls attention to the fact that the negative work in the compression pump

was deducted in the case of the tests of the Ericsson hot air engines, as well as in the tests of the Brayton petroleum motor and the Diesel motor, these various engines covering practically the entire period of practical work with the internal-combustion motor.

The matter is one of importance, mainly because it is desirable to have the reports of trials in comparable form, and it is probable that with the increasing practice of using engines to drive electrical generators, the efficiency will be determined upon the actual horse power developed, and measured by the electrical output, the use of the indicated power as a basis of efficiency being entirely superseded by the more practical ratio.

RAINFALL AND EVAPORATION.

EVAPORATION OBSERVATIONS IN THE UNITED STATES AND THEIR RELATION TO PRACTICAL IRRIGATION PROBLEMS.

H. H. Kimball—National Irrigation Congress.

IT is an interesting fact that although much attention has been given by engineers to the observation and study of the precipitation of water from the atmosphere, the reverse action, the absorption of water by the air, has been but little studied. Since artificial irrigation becomes necessary principally in dry climates it becomes of much importance to determine what proportion of the water supplied is lost in evaporation, and a paper by Mr. H. H. Kimball discussing this subject before the Twelfth National Irrigation Congress is therefore acceptable as a contribution to a question upon which there is little information available.

"It is important that irrigation engineers should know not only the rainfall, but also the evaporation over any given region. Unfortunately, the measurement of evaporation presents many more difficulties than the measurement of precipitation. In fact, the rate of evaporation from land surfaces depends upon so many different elements that it can be treated only in the most general manner. Thus, it has been shown that the evaporation from saturated soil covered with growing plants is greater than from water surfaces, but becomes less when the level of complete saturation falls a few inches below the soil surface, and continually diminishes as this level recedes to increasing depths. Also, the evaporation from a forest of evergreen trees is greater than from a forest of leafy trees; from the latter it is greater than from grass, from which in turn it is greater than from bare soil. The composition of the soil has its effect upon the rate of evaporation, and so also has the state of cultivation. Furthermore, the rate of evaporation from any surface has been found to vary with its temperature, with the quantity of moisture in the air, and with the wind velocity.

Mr. Kimball tabulates some of the results obtained by Mr. Rafter for the eastern part of the United States, which tend to show that from 20 to 26 per cent. of the rainfall disappears from the run-off, but these results can hardly be considered as applicable to other parts of the country where the atmosphere and the surface of the earth contain a much smaller proportion of moisture, besides which the accuracy of this method of determination can hardly be considered as altogether satisfactory.

"As a practical problem in irrigation, however, the evaporation from water surfaces is of much more importance than the evaporation from land surfaces. The engineer will naturally determine his water supply, not from the annual precipitation, but from the run-off of available streams. Having ascertained this, the question of losses becomes important, and if storage basins are of considerable area the loss by evaporation in a dry climate becomes very serious, having been estimated, in some cases, to be as much as 30 to 50 per cent. of the amount stored.

"Fortunately, the determination of the evaporation from a water surface presents fewer difficulties than the evaporation from land surfaces. Generally speaking, the determination may be made by two quite different methods: by direct measurements

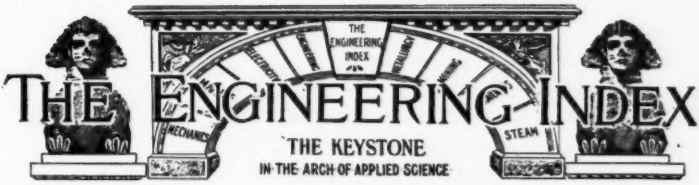
from properly exposed water surfaces, and by computations based upon the temperature of the water surface and the value of certain meteorological elements. With proper attention to exposure, direct measurements of evaporation from water surfaces should give the more reliable results. Unfortunately, proper exposure is not always practicable, and it is therefore necessary to consider the character of the exposure in connection with each series of evaporation experiments, and in some cases to apply a correction before the results will fairly represent the evaporations from a reservoir or a lake."

Among experimental investigations of the evaporation of water from exposed surfaces those of Mr. Desmond Fitzgerald are cited as being very complete, both as to the original data and the relations established between them. These experiments were conducted in connection with the reservoirs of the Boston waterworks, and gave data showing the connection between the rate of evaporation, the temperature of the water surface, the humidity of the atmosphere, and the wind. According to these investigations Mr. Fitzgerald established a formula in which the rate of evaporation could be computed from the vapor pressures corresponding to the temperature of the surface of the water and the humidity of the atmosphere, and the wind velocity. A similar formula has been derived by Professor L. G. Carpenter from observations made at Fort Collins, Colorado, and these are of interest because of the very different climatic conditions of the location. Mr. Kimball also examines the formula of Professor Russell, of the Weather Bureau, this being based upon a collation of Weather Bureau observations, and including the barometric pressure among the elements to be considered. With Professor Russell's investigations there is included a map showing lines of equal annual evaporation in inches from a free water surface, which is interesting especially as showing the variations in rate for different parts of the United States.

"Upon the organization of the Irrigation Survey by the U. S. Geological Survey in 1888, arrangements were made for measuring the evaporation at several points in the arid regions of the United States. It was recognized that the rate of evaporation depended upon the dryness of the air, the temperature of the water surface, and the velocity of the wind at the water surface. An effort was therefore made to measure the evaporation from a water surface having the same temperature as the surface of lakes or reservoirs, and exposed to the same wind velocity. To accomplish this galvanized-iron evaporating pans, three feet square and eighteen inches deep, were floated on the surface of the body of water from which the evaporation was to be measured. The pans were kept nearly full, with the surface of the water in them about on a level with the water outside. The evaporation was at first measured by some sort of gage, but later was determined from the amount of water that was added to bring the surface to the top of a pin projecting from the center of the pan. A record of the water temperature inside and outside the pans was kept. Usually a difference was noted, the inside temperature being higher in the daytime and lower at night. The average is, however, about the same in each. It is not probable that the water in pans is exposed to quite so high a wind velocity as the average over outside surfaces, but to offset this the water in the pans wets the sides, and this increases the evaporating surface. It is therefore assumed that in general the evaporation from a floating pan of this type when kept nearly full represents the evaporation from the outside water surface very closely."

Mr. Kimball tabulates the observations of the Geological Survey with computations from Russell's formula, and while the results are fairly comparable the computed evaporations are somewhat higher than the observed values. For practical engineering work the formulas of Fitzgerald and of Carpenter appear to be preferable.

This whole subject is of especial interest in connection both with irrigation and with municipal water supply, and in view of the manner in which observations have been gathered and discussed it appears to be entirely feasible to compute in advance the losses by evaporation with a degree of precision at least as high as many other elements in the whole problem.



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

A Few Points in the Design of Reinforced Concrete Arches. B. R. Leffler. Gives some short processes in the graphical analysis of the elastic arch, based on the method given by William Cain, with which the reader is supposed to be familiar. Ills. 1200 w. Pro Am Soc of Civ Engrs—April, 1905. No. 69269 E.

The Computations for a Monier Arch Subjected to Wind Pressure and to Inclined Loads (Die Berechnung eines Moniergewölbes für Windangriff und Abstürzende Lasten). Ernst Horowitz. Mathematical analysis of the wind pressure, etc. on a reinforced concrete arch of the Monier system. 3000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—March 25, 1905. No. 69158 D.

The Exe Bridge. Briefly describes the earlier bridges on the same site, and gives an illustrated detailed description of the new structure, which is an exceptionally

We supply copies of these articles. See page 477.

flat arch of 150 ft. span. 2000 w. Engng —March 24, 1905. No. 68756 A.

Erection.

Erection of the Cambridge Bridge, Boston. Brief illustrated description. 900 w. Eng Rec—April 15, 1905. No. 68974.

Failure.

Failure of a Bridge Pier on the Phoenix & Eastern R. R. Brief illustrated description of the failure of a concrete bridge pier in Arizona. 500 w. Eng News—April 6, 1905. No. 68840.

Highway Bridge.

Bridge over the Mattig at Braunau on the Inn (Brücke über den Mattigfluss bei Braunau a/I.). Gustav Hermann. Illustrating a highway truss bridge with middle span of 31.5 metres. 2500 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—April 1, 1905. No. 69159 D.

Pier.

A Large Concrete Pier with a Sheet Pile and Canvas Cofferdam. James C. Hain. States the conditions and gives an illustrated description of work at Kilbourn, Wis. 1200 w. Eng News—March 30, 1905. No. 68833.

Quebec Bridge.

The General Design of the Quebec Bridge. Illustrated detailed description of the structural features of the bridge over the St. Lawrence river, being the longest span yet undertaken. 2200 w. Eng Rec—April 1, 1905: Serial. 1st part. No. 68823.

Reinforced Concrete.

A Reinforced Concrete Foot-Bridge at Como Park, St. Paul, Minn. Illustrated description of bridge and construction. 600 w. Eng News—April 6, 1905. No. 68836.

Testing the Armoured Concrete Bridge at Soissons. Describes the tests made of a bridge of the Hennebique type in France, giving the results. 2500 w. Engr, Lond—March 24, 1905. No. 68757 A.

The Reinforced Concrete Bridge at Kankakee. R. D. Gregg. Detailed description of the construction. 2500 w. Eng Rec—April 1, 1905. No. 68829.

Suspension.

Suspension Bridge across the Rhone at Jons-Niévroz (Pont Suspendu de Jons-Niévroz sur le Rhone). J. Dor. Illustrating a highway suspension bridge of 200 metres clear span across the Rhone above Lyons. 2000 w. 1 plate. Génie Civil—March 18, 1905. No. 69114 D.

Transporter.

The Runcorn Transporter Bridge. Illustrations, with brief description of this aerial ferry. 400 w. Engng—April 7, 1905. No. 68920 A.

Viaduct.

The Cuyahoga Valley Viaduct. G. H. Tinker. Illustrates and describes the design of the new structure at Cleveland, O., stating some of the problems in the erection. 1300 w. R R Gaz—Vol. XXXVIII. No. 15. No. 68941.

Zambesi.

The Victoria Falls Bridge. Illustrated description of the highest bridge in the world in process of erection for the Rhodesian Railway Co. over the Zambesi river, and also describing the natural features of the locality. 2300 w. Engr, Lond—April 7, 1905. No. 68993 A.

The Zambesi Bridge. Editorial on the closing of the two arms of this great steel arched bridge spanning the Zambesi gorge over 400 ft. above water-level. 1300 w. Engng—April 7, 1905. No. 68919 A.

CONSTRUCTION.

Acoustics.

Architectural Acoustics. G. R. Anderson. Considers the problems of construction that relate to the regulation of sound. Discussion. 2500 w. Can Archt—March, 1905. No. 68739 C.

Bins.

The Strength of the Walls of Grain Bins (Calcul des Parois des Silos à Grains). Alexandre Sée. Working out the method for calculating the lateral pressure of grain, and deriving formulas for practical use in constructing bins. 2000 w. Génie Civil—April 8, 1905. No. 69121 D.

Building Construction.

Engineering Features of the New England Conservatory of Music, Boston. Howard S. Knowlton. Illustrates and describes the construction of a building to meet the needs of about 1,500 students in instrumental and vocal music. 2500 w. Eng Rec—April 1, 1905. No. 68827.

Central Stations.

Cement in Central Station Design. Eugene B. Clark. On the use of cement in the building of power-houses, as illustrated in a recently completed plant of the Illinois Steel Company in South Chicago. 4000 w. Am Inst of Elec Engrs—April, 1905. No. 69032 D.

Chimneys.

Tall Chimney Construction. Discusses problems in connection with the design and construction of tall chimneys. Illus. 2800 w. Builder—April 8, 1905. No. 68975 A.

Coal Pocket.

The Building of a Concrete Coal Pocket. John M. Bruce. Illustrates and

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describes an interesting example of reinforced concrete construction at Bradford, R. I. 1500 w. Cement Age—March, 1905. No. 68730.

Coffer Dams.

Coffer Dams in Reinforced Concrete (Batardeaux en Béton Armé). M. Tricon. Describing especially the use of reinforced concrete for coffer dams in constructing canal locks and similar works. 1800 w. Revue Technique—March 25, 1905. No. 69139 D.

Cost Keeping.

See Industrial Economy.

Dams.

A Hollow Reinforced Concrete Dam at Schuylerville, N. Y. Illustrated detailed description. 2000 w. Eng News—April 27, 1905. No. 69251.

Construction, Repairs and Subsequent Partial Destruction of the Arizona Canal dam, Near Phoenix, Ariz. H. F. Robinson. Illustrated report. 1000 w. Eng News—April 27, 1905. No. 69252.

The Stability of Masonry Dams. A review of the application of the theory of Atcherly and Pearson to the stability of the Assouan dam, showing the importance of considering the vertical stresses. 1800 w. Engng—March 31, 1905. No. 69177 A.

Masonry Dams. An editorial reviewing the paper of Atcherly and Pearson upon disregarded points in the stability of masonry dams, showing the relation of the theory to the Assouan dam. 2000 w. Engr, Lond—March 31, 1905. No. 69178 A.

The Barossa Dam, Southern Australia. Emile Guarini. Illustrations, with brief description, of a curved concrete dam recently finished. 700 w. Sci Am—April 1, 1905. No. 68846.

Domes.

Theory of the Spherical or Conical Dome of Reinforced Concrete or Metal. William Cain. The domes considered are supposed to be solids of revolution, as to figure, and to be constructed of material such as metal or reinforced concrete, capable of sustaining either tensile or compressive stresses. 7800 w. Ills. Pro Am Soc of Civ Engrs—April, 1905. No. 69270 E.

Failures.

An Expert Report on the Collapse of Buildings in New York City. Report of the Board of expert engineers on the causes of the fall of several nearly completed buildings. Considers the failures were due to defective construction—slovenly mason work and poor mortar. 1200 w. Eng News—April 13, 1905. No. 68954.

Fireproof Construction.

Concrete Seat-Bank Construction in the Chicago Orchestra Building. Illustrated description of features in an auditorium where special effort has been made to secure fireproof construction. 1000 w. Eng News—April 6, 1905. No. 68839.

Foundations.

A Few Remarks on Foundations. L. L. Buck. Some remarks on the question of the distribution of the load. 1000 w. Pro Am Soc of Civ Engrs—April, 1905. No. 69267 E.

Grain Elevator.

Large Grain Elevator at Weehawken. J. C. Irwin. Illustrated description of a 2,000,000 bushel fireproof elevator belonging to the New York Central. 2000 w. R R Gaz—Vol. XXXVIII. No. 14. No. 68821.

The Weehawken Elevator of the New York Central & Hudson River R. R. J. C. Irwin. Fully illustrated description of a 2,000,000 bushel fireproof elevator. 2300 w. Eng Rec—April 8, 1905. No. 68893.

Grandstand.

The Belmont Park Steel Grandstand. Illustrates and describes the engineering and architectural features of a steel grandstand at this race course on Long Island, near New York City. It is 116 ft. wide, 650 ft. long, and about 55 ft. high, having a seating capacity of 11000. 2500 w. Eng. Rec—April 22, 1905. No. 69217.

Reinforced Concrete.

Reinforced Concrete Resistance at Port Antonio, Jamaica Island. Illustrates and describes an unusual winter home recently completed. 1400 w. Eng Rec—April 8, 1905. No. 68897.

The Reinforced Concrete Pugh Power Building, Cincinnati, O. Illustrates and describes a building of this material, to be used for manufacturing purposes. 1500 w. Eng Rec—April 15, 1905. No. 68971.

See Also Civil Engineering, Bridges.

Simplon Tunnel.

The Construction of the Simplon Tunnel. Leon Monete. A very fully illustrated account of the work, including the project, the mechanical equipment, and the manner in which the numerous difficult engineering problems were solved. 3500 w. Engineering Magazine—May. 1905. No. 69171 B.

MATERIALS OF CONSTRUCTION.

Brick.

Results of Tests of Common Building Brick for the Bureau of Buildings, New York City. Ira H. Woolson. Describes

experiments including tests of transverse and crushing strength, absorption, fire and freezing tests. 3000 w. Eng News—April 13, 1905. No. 68951.

Cement.

Cement Posts. C. L. Catherman. Read before the Iowa Cement Users Convention. Discusses the proper making and reinforcing of cement posts, and problems arising in their use. 2000 w. Munic Engng—April, 1905. No. 69013 C.

Irregular Methods of Testing Cement. H. A. Schaffer. Read before the Assn. of Portland Cement Mfrs. Points out errors made by many cement testers employed by contractors, engineers, and architects. 4500 w. Cement Age—March, 1905. No. 68732.

Natural Hydraulic Cement. Edwin C. Eckel. Discusses the grinding of the clinker, and types of grinding machinery. 3000 w. Munic Engng—April, 1905. No. 69011 C.

Testing Cements and Asphalts. Prof. A. W. Dow. Digest of a report giving rules and methods recommended. 2500 w. Munic Jour & Engr—April, 1905. No. 68805 C.

The Cement Industry. Frederick W. Huber. Gives a classification of materials discussing their composition, and the process of manufacture of Portland cement. 5000 w. Cal Jour of Tech—Feb., 1905. No. 69023 C.

The Decomposition of Cements by Sea Water. Henri Le Chatelier. Abstract translation of a paper prepared for the St. Petersburg Congress of the International Society for Testing Materials. Specially considers the chemical action. 5200 w. Cement Age—March, 1905. No. 68731.

The Pacific Portland Cement Co. W. W. Whitton. An illustrated article describing the process of manufacture as carried out by this California company. 3800 w. Cal Jour of Tech—Feb., 1905. No. 69021 C.

Concrete.

Practical Notes on Concrete Manipulation. From a paper by Charles A. Matcham, before the Nat. Bldrs.' Sup. Assn. Describes methods of constructing buildings of concrete. Ills. 3300 w. Eng Rec—April 15, 1905. No. 68970.

The Proportions of Ingredients in Portland Concrete. Richard T. Dana. Gives diagrams showing amounts of cement, sand and stone or gravel in concrete for different percentages of voids; explaining method of use. 2400 w. Eng News—April 20, 1905. No. 69077.

Water Tightness of Concrete. Frederick W. Taylor, and Sanford A. Thompson. Selected from Taylor and Thompson's Treatise on Concrete, Plain and Reinforced. Information on methods of securing water tight work. 3500 w. Munic Engng—April, 1905. No. 69010 C.

Testing.

Regulations of the Bureau of Buildings, Borough of Manhattan, for the Testing of New Materials of Construction. Gives regulations based on common brick as a standard, using the results obtained by Prof. Ira H. Woolson. 1200 w. Eng News—April 13, 1905. No. 68952.

Timber.

Methods and Cost of Creosoting Timber. Oswald T. Dunn. Condensed from an article in *The Polytechnic*. Describes methods in use. 1400 w. Eng News—April 27, 1905. No. 69250.

The Strength of Timber Treated with Preservatives. From. Bul. U. S. Bureau of Forestry. Effect of steaming and different preservative chemicals and processes upon both green and seasoned lumber. 1400 w. St Ry Rev—April 15, 1905. No. 69068 C.

MEASUREMENT.

Formula.

A Simple Demonstration of the Prismoidal Formula. Gives a geometrical demonstration of this formula, showing its application. 700 w. Eng News—April 6, 1905. No. 68841.

Maps.

Municipal Sub-Surface Construction Maps. Herbert S. Wynkoop. A description of the Philadelphia plan of giving information to contractors which enables them to know the conditions below the surface, thus making possible the opening of streets for repairs and other work, and the quickest possible closing. Map. 1800 w. Eng Rec—April 1, 1905. No. 68830.

Sighting.

Aiming by Telescope Sight Compared with Aiming by Open Sights. Dr. S. Crapski. A physico-physiological study of the advantages gained by the use of telescopes in aiming and laying guns. Ills. 7300 w. Pro U S Nav Inst—March, 1905. No. 69098 G.

Stream Discharge.

A Convenient Method for Determining the Discharge of Streams and Canals I. H. Cunningham. Describes a method in the use of which the intervals between meter stations may be made any convenient distance. 350 w. Eng News—April 6, 1905. No. 68843.

A Method of Computing Flood Discharge and Cross-Section Area of Streams. E. G. Murphy. Gives methods for finding these measurements, with ta-

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bles. 1500 w. Eng News—April 6, 1905. No. 68838.

Wind Measurements.

The Julliot Anemometric Balloon. Translated from *La Nature*. Illustrated description of an apparatus for measuring the direction and velocity of the wind at different heights. 800 w. Sci Am Sup—April 15, 1905. No. 68937.

MUNICIPAL.

Boulevard.

Construction of Sections 3 and 4, Riverside Drive Extension, New York. Illustrated description of the construction of the drive from 145th St. to 158th St. 1000 w. Eng Rec—April 15, 1905. No. 68969.

Dust.

Methods of Dust Abatement and Prevention (Les Moyens de Combattre ou d'Empêcher la Poussière). G. Forestier. A discussion of methods of sprinkling and of preventing the formation of dust on streets and highways. 7000 w. Mem Soc Ing Civ de France—Dec., 1904. No. 69160 G.

Fire Engines.

The Modern Steam Fire Engine. F. F. Loomis. Abstract of a paper before the Ohio Soc. of Mech. & Steam Engrs. Considers the requirements of fire engines and describes modern engines and the methods of handling that will give the best results. 1500 w. Ir Age—April 6, 1905. No. 68791.

Maps.

See Civil Engineering, Measurement.

Pavements.

Specifications for Laying Asphalt Pavements. Gives the new specifications for the laying of asphalt pavements in the city of San Francisco. 1600 w. Cal Jour of Tech—Feb., 1905. No. 69024 C.

Refuse.

British Refuse Destructors and American Garbage Furnaces. An editorial on the poor results in America as compared with Great Britain, and some of the causes. 2800 w. Eng News—April 13, 1905. No. 68953.

British Refuse Destructors. Notes on the destructors of four London boroughs giving a general idea of the conditions. 6500 w. Eng News—April 13, 1905. Serial. 1st part. No. 68950.

The Land Disposal of Garbage: An Opportunity for Engineers and Contractors. Editorial on the experiment at St. Louis, where the garbage is plowed into the land on an island in the river. 2500 w. Eng News—April 6, 1905. No. 68844.

Septic Tanks.

The Mosman Septic Tanks, Sydney, N. S. W. Notes from the official report of L. A. B. Wade concerning the construction of four septic tanks, a grit chamber, eight filter beds and two gear chambers. 1000 w. Eng Rec—April 22, 1905. No. 69218.

Sewage.

Sewage Purification Plants in Ohio. Information from the annual report of the State Board of Health of Ohio, with illustrations of some of the plants. 2500 w. Munic Engng—April, 1905. No. 69009 C.

The Bacteriolysis of Peptones and Nitrates. Stephen De M. Gage. An investigation into types of bacteria normally present in sewage and the effluents of sewage disposal systems. 12000 w. Tech Qr—March, 1905. No. 69006 E.

The Interpretation of a Sewage Analysis. Earle B. Phelps. Considers raw or untreated sewages and septic sewages and the interpretation of analytical data. 7400 w. Tech Qr—March, 1905. No. 69007 E.

Sewers.

The Cost of Reinforced Concrete Sewers. Information given by Walter C. Parmley in a recent paper before the Boston Soc. of Civ. Engrs., referring to work done on sewers in Cleveland during the last three years. 1500 w. Eng. Rec—April 8, 1905. No. 68892.

WATER SUPPLY.

Amsterdam.

The Water Supply of Amsterdam, Holland. W. P. Mason. Explains how the supply of water is secured from the sand-dunes. 1000 w. Eng News—April 27, 1905. No. 69248.

Artesian Wells.

Artesian Flows from Unconfined Sandy Strata. Myron L. Fuller. Describes flows from artesian wells sunk wholly in sand, discussing the cause. 1200 w. Eng News—March 30, 1905. No. 68832.

The New Artesian Water Supply of Ithaca, N. Y. F. L. Getman. Describes the geological formations, the distribution and arrangement of the wells, the collection system, and costs. Ills. 2800 w. Eng News—April 20, 1905. No. 69081.

Conduits.

The Torresdale Conduit. John W. Hill. A fully illustrated detailed description of a large inverted siphon belonging to the filtration system of the water supply of Philadelphia, with the history of its construction, examination, and present condition. General discussion. 15000 w.

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Pro Engrs' Club of Phila—April, 1905. No. 69034 D.

Evaporation.

Evaporation Observations in the United States. Herbert Harvey Kimball. Read before the Irrigation Congress, at El Paso, Tex. Gives tabulated results of measurements of evaporation made at various points, with explanatory remarks. Map. 2000 w. Eng News—April 6, 1905. No. 68837.

Filtration.

A Reinforced Concrete Filtration Plant at Marietta, Ohio. Illustrations, detail sections and description of construction. 1200 w. Eng Rec—April 22, 1905. No. 69213.

The Sand Filtration Plant of the Indianapolis Water Works. W. C. Mabee. From a paper before the Indianapolis Tech. Club. Illustrated detailed description of the plant and information concerning the source of supply. 3200 w. Munic Engng—April, 1905. No. 69012 C.

Gloucester, Mass.

Haskell's Brook Reservoir and Dam, Gloucester, Mass. H. W. Spooner. Illustrates and describes the construction of the new impounding reservoir, the preparation of the basin, and the building of the dam. 2000 w. Jour N Eng W-Wks Assn—March, 1905. No. 69054 F.

Irrigation.

The Irrigation Project of the Canadian Pacific Railway. Illustrated description of the system of irrigation undertaken by this railway for the purpose of promoting the settlement of that portion of its land which requires irrigation. 2800 w. Eng News—April 27, 1905. No. 69246.

The Irrigation System of Ontario, California—Its Development and Cost. F. E. Trask. Treats of the development and present status of an irrigation plant in the "Orange Belt" of Southern California, and gives details and cost of a system designed to meet exacting demands for "high duty and maximum utility." 2200 w. Ills. Pro Am Soc of Civ Engrs —April, 1905. No. 69268 E.

Pipe Laying.

Method of Laying a Triple Line of 60-in. Cast-Iron Pipe. Seth M. Van Loan. Brief Illustrated description of methods used in Philadelphia for filtered water distribution from Torresdale filters. 1200 w. Eng News—April 6, 1905. No. 68835.

Pumping.

The Direct Pumping Method of Water Supply in Use at Taunton, Mass. George A. King. Gives an account of the reasons for installing this system, and describes its features; also its operation and cost of working. 2000 w. Jour N Eng W-Wks Assn—March, 1905. No. 69053 F.

Pump Well.

Difficulties with a Pump Well. Illustrated description of the construction of a pump well at Atlantic City, N. J., which was accomplished with some difficulty. 1200 w. Eng Rec—April 1, 1905. No. 68828.

Reservoirs.

Repairs to the Lining of a Small Reservoir on Powder Horn Hill, Chelsea, Mass. Caleb Mills Saville. Illustrated notes on a piece of work recently carried out, giving methods and cost. 2000 w. Jour N Eng W-Wks Assn—March, 1905. No. 69057 F.

The Opening of the New Croton Reservoir. An interesting account, fully illustrated, of the rise of water behind the new dam, after the shutting down of the gates, with other information about the water supply of New York City. 1800 w. Sci Am—April 15, 1905. No. 68936.

St. Louis.

Ice at the Intake of the St. Louis Water Works. Edward E. Wall. Describes the arrangements for protecting the intake tower from ice, and an account of the trouble during the severe weather of the past winter. Ills. 900 w. Eng Rec—April 15, 1905. No. 68973.

Stave Pipe.

Wooden Stave Pipe. W. C. Hawley. Brief description of the construction, discussing the merits, and giving extracts from specifications. Discussion. Ills. 5400 w. Pro Engrs' Soc of W Penn—April, 1905. No. 69038 D.

Sterilization.

The Water Sterilization Works at Saint Maur. Emile Guarini. Illustrates and describes experimental works for the sterilization of water by the use of ozone at these works in Paris. 1500 w. Elec Engr, Lond—April 14, 1905. No. 69233 A.

Valves.

Regulating Valve. J. W. Ledoux. An illustrated description of an apparatus for regulating the flow of water with gravity supplies. Discussion. 1700 w. Pro Engrs' Club of Philadelphia—April, 1905. No. 69036 D.

Water Tower.

Description of Concrete-Steel Water Tower and Standpipe at Fort Revere, Hull, Mass. Leonard S. Doten. Illustrated detailed description of unusual concrete steel construction. Discussion. 2500 w. Jour N Eng W-Wks Assn—March, 1905. No. 69055 F.

Water Tank and Tower for East Providence, R. I. F. M. Bowman. Illustrated

detailed description of a structure the largest of its type. Also discussion. 4000 w. Jour N Eng W-Wks Assn—March, 1905. No. 69056 F.

Water-Works.

The New Gravity Water-Works at Hudson, N. Y. Illustrates and describes a storage reservoir and pipe line just completed. 2800 w. Eng Rec—April 1, 1905. No. 68824.

Wisconsin.

The Public Water Supplies of Wisconsin. W. C. Kirchoffer. A report of the sources of supply, quality and treatment of waters, &c. 3800 w. Wis Engr—April, 1905. No. 69243 D.

WATERWAYS AND HARBORS.

Argentina.

The New Port of Rosario in the Argentine Republic (Le Nouveau Port du Rosario dans la République Argentine). Georges Hersent. A very full account of the new harbor works at Rosario, on the Parana, above Buenos Ayres. 7500 w. 2 plates. Mem Soc Ing Civ de France—Jan., 1905. No. 69162 G.

Bruges.

The Harbors and Maritime Canal of Bruges (Les Ports et le Canal Maritime de Bruges). L. Coiseau. A very full account of the ship canal connecting Bruges with the North Sea; together with other harbor improvements. 16,000 w. 9 plates. Mem Soc Ing Civ de France—Dec., 1904. No. 69161 G.

Canada.

Port Colborne Harbor Works. J. M. Hogan. Student's prize paper read before the Canadian Soc. of Civ. Engrs. Illustrated description of harbor improvements at the Lake Erie end of the Welland canal. 1000 w. Can Engr—April, 1905. Serial. 1st part. No. 68871.

Docks.

Fire Protection of the Stuyvesant Docks. H. W. Parkhurst. Illustrations of the destruction by fire of these New Orleans docks, with remarks on the provisions for fighting fire and preventing its spreading. 1000 w. R R Gaz—Vol. XXXVIII. No. 13. No. 68818.

Dredgers.

European and American Dredges. Frank C. Perkins. Illustrates and describes various types used. 2000 w. Min Rept—April 13, 1905. No. 68960.

Modern Sea-Going Dredgers. Illustrations, with description of the dredgers "Savannah" and "Coronation," the latter a British dredger. 2500 w. Naut Gaz—April 6, 1905. No. 68876.

Stern-Wheel Government Dredge for Florida Waters. Illustrated description of the dredge and snag-boat "Florida," built for service on the St. John and other Florida rivers. 2800 w. Naut Gaz—April 13, 1905. No. 68955.

Drydock.

New Masonry Drydock at the Boston Navy Yard. Illustrated description of the fine stone-and-concrete drydock recently completed. It is one of the largest in the world and embodies all the modern improvements. 1200 w. Sci Am—April 29, 1905. No. 69253.

Egypt.

Inland Navigation in Egypt. Sir Hanbury Brown. A review of what has been done to develop the inland waterways of Egypt, as a contribution to the collection of facts concerning the policy of nations with regard to their inland waterborne transport. Map. 3500 w. Engr, Lond—March 31, 1905. Serial. 1st part. No. 68909 A.

Lighthouses.

Improvements in English Lighthouses. Illustrated description of new lanterns recently placed at St. Catherine's and two other electrically illuminated English lighthouses. 2000 w. Engr, Lond—April 14, 1905. No. 69238 A.

Liverpool.

The Improvement of the Port of Liverpool (Les Améliorations du Port de Liverpool). Bryson Cunningham. With plans of the docks and a review of the development of the port. 1800 w. Génie Civil—April 1, 1905. No. 69117 D.

Missouri.

Technical Methods of River Improvement, as Developed on the Lower Missouri River by the General Government from 1876 to 1903. Discussion of the paper by S. Waters Fox. Ills. 7700 w. Pro Am Soc of Civ Engrs—April, 1905. No. 69271 E.

Nile.

The Asyut Barrage Across the Nile. Notes from a paper by George H. Stephens, presented before the Inst. of Civil Engrs., describing this work in Egypt. Ills. 2500 w. Eng Rec—April 15, 1905. No. 68968.

The Safety of the Assuan Dam. Reviews facts concerning the structure, and the recently printed opinions of Mr. Atcherley. 2000 w. Eng Rec—April 22, 1905. No. 69215.

Ohio.

From Pittsburg to Tidewater. An illustrated article discussing the proposed

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canalization of the Ohio river from Pittsburg to the Mississippi. 2500 w. Marine Rev—April 6, 1905. No. 68877.

Ohio River and Its Improvement. Gives a statement showing the distribution and fall of the river, its tributaries, with the improvements under discussion, the commerce of the river, &c. 4500 w. Marine Rev—April 13, 1905. No. 68931.

Panama.

A New Plan for the Panama Canal. An explanation of the project submitted by Lindon W. Bates, which provides for terminal lakes and a 20-foot summit level. Also suggests an alternative plan with higher summit level. 1500 w. Eng Rec—April 22, 1905. No. 69216.

Machinery On the Panama Canal. H. Prime Kieffer. An illustrated account of the repair work under way to make ready for use the machinery already on the Isthmus, with some information relating to the work to be accomplished. 3000 w. Mod Mach—April, 1905. No. 68733.

Modern Excavating Machinery for the Panama Canal. A. W. Robinson. Mr. Robinson's second paper gives a general review of the latest and most powerful types of excavating and dredging machinery available for use on the Panama canal works. 2500 w. Engineering Magazine—May, 1905. No. 69170 B.

Panama in French Canal Times. W. F. Dennis. Notes on the conditions of the isthmus during the operations of the French Company are reviewed. Ills. 3000 w. Eng Rec—April 1, 1905. No. 68825.

Report of the Chief Engineer of the Isthmian Canal Commission. Report of John F. Wallace, with editorial comment. 8500 w. Eng News—April 20, 1905. No. 69083.

Stream Discharge.

See Civil Engineering, Measurement.

Streams.

Characteristics of Two Companion Streams of the Plains. E. C. Murphy. Information in regard to the Neosho and Verdegris Rivers, two tributaries of the Arkansas River, showing remarkable fluctuations in flow. 2500 w. Eng News—April 27, 1905. No. 69247.

Wharf.

The Steel and Concrete Wharf at Tampico. Information concerning this unusual wharf, taken from a monograph by E. H. Connor. Describes the main and lateral wharves and their construction. 2000 w. Eng Rec—April 8, 1905. No. 68895.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

The Power Plant of a Modern Telephone Exchange. A. Dallam O'Brien. Considers methods employed in charging the storage batteries and related matters. 3000 w. Am Elect'n—April, 1905. No. 68812.

Induction.

The Reduction of Induction in Cables for Weak Currents (Ueber die Vermeidung der Induktion bei Schwachstromkabeln). J. Schmidt. A discussion of the best arrangement of wires in telephone and telegraph cables to minimize induction effects. 3500 w. Zeitschr f Elektrotechnik—March 19, 1905. No. 69153 D.

Pupin System.

The First Pupin Telephone Installation in Austria (Die Erste Pupin'sche Telephonleitung in Oesterreich). R. Nowotny. An account of the construction and operation of the line between Vienna and Innsbruck, using the Pupin inductance coils. 4000 w. Zeitschr f Elektrotechnik—March 26, 1905. No. 69154 D.

Space Telegraphy.

Artom Selective System of Wireless Telegraphy. A. Frederick Collins. An account of experiments made with this new wireless system of telegraphy with elliptical or circular rays of electric power. 1800 w. Elec Wld & Engr—April 22, 1905. No. 69212.

New American System of Wireless Telegraphy. James Foster King. A statement of the transmitting formula of the writer's system. 1000 w. Elec Wld & Engr—April 15, 1905. No. 68965.

The Control of Action at a Distance by Means of Electric Waves (Distribution et Controle d'Actions Produites à Distance par les Ondes Electriques). Edouard Branly. Discussing the practicability of employing the methods of space telegraphy for starting motors, igniting explosives, and similar actions at a distance. 1200 w. Comptes Rendus—March 20, 1905. No. 69123 D.

Telephony.

A New Underground Cable System. Axel Hultman. Illustrated description of a method worked out by the writer. 1000

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w. Elec Rev, Lond—April 14, 1905. No. 69229 A.

DISTRIBUTION.

Cables.

The Arrangement and Installation of Cable Protection Devices (Ueber Kabelschulzhullen deren Herstellung und Verlegen). J. Schmidt. With especial reference to the construction of underground conduits and methods of providing external protection for cables laid beneath the surface. Two articles—8000 w. Electrotech Zeitschr—April 16, 13, 1905. No. 69150 each B.

Converters.

The Starting of Rotary Converters. Sydney Woodfield. Considers briefly all the methods one is likely to meet with. 2500 w. Elec Rev, Lond—April 21, 1905. No. 69259 A.

Cut-Outs.

Low-Tension Thermal Cut-Outs. Alfred Schwartz and W. H. N. James. A brief résumé of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. States the requirements of an efficient protective device and shows the influences that may affect a fuse wire. Discussion. 3000 w. Elec Engr, Lond—March 24, 1905. No. 68749 A.

Safety Switch.

Electric Switches and Description of a Patent Safety Switch for Use in Mines. William Maurice. Read at Nottingham meeting of Nat. Assn. of Col. Mgrs. Gives the rules relating to the design and application of switches formulated by the Inst. of Elec. Engrs., and gives an illustrated description of design. 2000 w. Ir & Coal Trds Rev—April 7, 1905. No. 68991 A.

Switchboards.

Notes on the Use of Instruments on Switchboards. F. P. Cox. To introduce a discussion on the more important features of instrument engineering, confining the remarks to the conditions which are found on switchboards in central stations. 1200 w. Am Inst of Elec Engrs—April, 1905. No. 69029 D.

Transformers.

Care and Operation of Transformers. M. A. Sammett. Suggestions for the care and operation of both service and station transformers. 2500 w. Can Elec News—April, 1905. No. 69060.

Flux Distribution in Design. A. Press. Gives two cases, showing the effect of the lack of uniformity of distribution of magnetic flux in transformers. Also editorial. 1700 w. Elec Wld & Engr—April 8, 1905. No. 68890.

Transformer Practice. C. W. Humphrey. Describes some of the tests necessary to judge of the values of transformers, explaining the methods used and the reasons for them. 2500 w. Elec Wld & Engr—April 8, 1905. No. 68889.

Wiring.

How to Remember the Wire Table. Charles F. Scott. An explanation of a few simple relations of the wire table for the B. & S. gauge copper wire that will enable the whole table to be constructed mentally. 1400 w. Elec Club Jour—April, 1905. No. 69094.

The Inspection of Electrical Conductors, With Especial Reference to Fire Protection. Washington Devereux. A statement of the progress and present condition of the science of interior wiring for the protection of buildings from fire. 4000 w. Jour Fr Inst—April, 1905. No. 69037 D.

ELECTRO-CHEMISTRY.

Accumulators.

Care and Preservation of the Lead Cell Exide Storage Battery. Excerpts from a recently issued pamphlet giving instructions for the proper care and preservation of this storage battery. 2400 w. Automobile—April 8, 1905. Serial. 1st part. No. 68874.

Recent Improvements in Portable Accumulators (Die Letzten Neuerungen auf dem Gebiete Transportabler Akkumulatoren). E. Sieg. Describing especially alkaline batteries of the Edison-Jungner type, showing the effective weight per unit of various types. 4000 w. Elecktrotech Zeitschr—March 30, 1905. No. 69,149 B.

Address.

The Role of Electrochemistry in Modern Technology (Die Rolle der Elektrochemie in der Modernen Technik). Dr. Haber. An address showing the relation between electrochemistry and engineering work. 4500 w. Zeitschr d Ver Deutscher Ing—March 18, 1905. No. 69102 D.

Copper.

Investigations upon the Electrolytic Properties of Copper Sulphide (Versuche ueber das Elektrolytische Verhalten von Schwelfelkupfer). G. Bödlander & K. S Idaszewski. Data and results of exhaustive experiments bearing upon the electrolytic separation of copper direct from the sulphide. 7500 w. Zeitschr f Elektro-Chemie—March 24, 1905. No. 69,157 D.

Electrolytic Slime.

Electrolytic Treatment of Electrolytic Slime. Anson G. Betts. An illustrated account of experimental investigation. 4500 w. Elec-Chem & Met Ind—April, 1905. No. 68775 C.

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Furnaces.

Experiments with an Electro-Thermic Muffle Furnace. F. A. J. Fitz-Gerald. Illustrated detailed description of the construction of an electric muffle furnace, and an account of experiments made in it. 3800 w. Elec-Chem & Met Ind—April, 1905. No. 68773 C.

Refractory Materials for Furnace Linings. E. Kilburn Scott. A Faraday Society paper, giving details on the use of carborundum and of electrically shrunk magnesite for furnace linings. 2500 w. Elec-Chem & Met Ind—April, 1905. No. 68774 C.

ELECTRO-PHYSICS.

Induction Coil.

The Construction of a Four-Inch Spark Induction Coil. Thomas R. Hopper. Illustrated detailed description. 3000 w. Sci Am Sup—April 8, 1905. No. 68855.

Insulation.

Tests to Determine the Comparative Heat Conduction and Radiation of Insulating Varnishes. John C. Dolph. Describes tests made to determine the combined heat radiation and conduction of various varnishes, giving results. 1800 w. Elec Rev, N. Y.—April 1, 1905. No. 68789.

Magnetism.

Recent Experiments on the Nature of Magnetism. Emile Guarini. A review of some of the results of researches by Herr Joannes Zacharias. Ills. 3300 w. Sci Am Sup—April 15, 1905. No. 68939.

Unsolved Problems.

Unsolved Problems in Electrical Engineering. Col. R. E. B. Crompton. The "James Forrest" lecture, delivered at the Inst. of Civ. Engrs., April 10, 1905. Classifies the problems into two groups, those set by Nature, and those which have developed in applying electrical energy to man's service. Discusses some of the problems. Full paper. 8500 w. Engng—April 14, 1905. No. 69234 A.

Unsolved Problems in Electrical Engineering. Col. R. E. B. Crompton. Abstract of the "James Forrest" lecture, delivered before the Inst. of Civ. Engrs., with editorial. Discusses a few of the most pressing problems. 5800 w. Elect'n, Lond—April 14, 1905. No. 69231 A.

Waves.

Methods of Decomposing Sine Waves (Methods der Zerlegung in Sinuswellen). C. Runge. A mathematical discussion of the analysis of periodic wave action and its separation into its simple elements. 4000 w. Elektrotech Zeitschr—March 16, 1905. No. 69144 B.

GENERATING STATIONS.

Costs.

An Analysis of Central Station Operating Costs and Revenue. H. S. Knowlton. A discussion of the costs of electric lighting as deduced from the report of the Massachusetts State Board, covering returns from 115 modern stations. 2500 w. Engineering Magazine—May, 1905. No. 69176 B.

Dynamo.

A New Generator. William Ashabel Johnson. Illustrated description of an alternating current generator of the revolving field type. 1800 w. Can Elec News—April, 1905. No. 69061.

Erection.

The Erection of Alternating-Current Machines. R. Scott. Describes the three types of machines and discusses the erection and preliminary operation of alternators. 4800 w. Power—April, 1905. No. 68795 C.

Generating Sets.

The Economy of Small Generating Sets (Les Petits Groupes Electrogenes considérés au Point de Vue de la Production Economique de l'Energie Electrique). R. Friédérich. An examination of the cost of electricty as generated by small steam, gas, and oil engines. 3000 w. Revue Technique—March 25, 1905. No. 69,-142 D.

Hydro-Electric.

Harnessing the Victoria Falls for Electrical Power. An illustrated article giving information of the power scheme to be carried out in Africa on the Zambesi River. 1500 w. Sci Am—April 29, 1905. No. 69254.

Headworks of the Plant of the Toronto & Niagara Power Co., Niagara Falls. Illustrations, showing the general features of the headworks with description of the construction. 1000 w. Eng Rec —April 8, 1905. No. 68894.

Hydro-Electric Power Development and Transmission in California. Robert McF. Doble. Brief historical review of the methods of transmitting the power of California mountain streams over long distances. Ills. 9500 w. Jour Assn of Engng Socs—March, 1905. No. 69045 C.

Largest Electric Water Power in Maine. Illustrated detailed description of the plant at Deer Ribs on the Androscoggin River, near Lewiston, Me. 2800 w. Elec Wld & Eng—April 8, 1905. No. 68888.

Niagara Power at Goat Island. Alton D. Adams. A discussion of present conditions at Niagara Falls, and the danger of drying up the American falls, and in that case, the value of Goat Island as a

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power site. 1600 w. Sci Am—April 15, 1905. No. 68935.

The Gersthofen Hydro-Electric Power Station. Notes on the extensive utilization of water power in the neighborhood of Augsburg, Bavaria, with illustrated detailed description of the plant named. 1700 w. Engr, Lond—April 14, 1905. No. 69240 A.

The 36,000-Volt Hydro-Electric Installation of the Cellina (Italy). Enrico Bignami. Illustrates and describes the first installation on the Cellina River, which is to supply electrical energy in the district of Venice. 2200 w. Elec Rev, Lond—April 7, 1905. No. 68986 A.

Use of Pacific Coast Water Powers in Electrical Operation of Railroads. Robert McF. Doble. Conclusion of a paper read before the Pacific Coast Ry. Club. An illustrated description of the single phase alternating-current equipment, and a review of what has been accomplished in California and other Pacific Coast States. 6000 w. Jour of Elec—April, 1905. No. 68822 C.

Water-Power Plant for a Cordite Factory in India. Illustrated description of the hydraulic plant recently erected to furnish the power required for electrically driving the new Government cordite factory in the Nilghiri Hills, India. 1500 w. Engr, Lond—March 31, 1905. No. 68911 A.

Labor Saving.

Labor-Saving Machinery in Central Stations. Discusses the reckless adoption of labor saving machinery under unsuitable conditions. 2000 w. Elec Rev, Lond—April 7, 1905. No. 68987 A.

Management.

Central Station Management. George S. Carson. Suggestions tending to economy of operation, and good service. 1700 w. Elec Wld & Engr—April 15, 1905. No. 68966.

Power Plant.

The Water and Electric Power Plant of the Utah Sugar Company. W. P. Hardesty. Illustrated description of a plant built entirely for irrigation, but made available for power. 3500 w. Eng News—April 13, 1905. No. 68948.

Tropical Plant.

The Electric Plant at Medellin, Colombia, S. A. C. H. Hines. Describes a typical plant in the tropics, showing the difficulties to be overcome. 1500 w. Elec Wld & Engr—April 15, 1905. No. 68963.

University Plant.

The Central Light, Heat and Power Plant at the University of California. G. C. Noble. Illustrated description of this new plant which supplies light, heat, and power for the various buildings and laboratories, and also serves as an experimental equipment. 2500 w. Engr, U S A —April 15, 1905. No. 68905 C.

LIGHTING.

Illumination.

A Field for the Illuminating Engineer. L. B. Marks. Discusses the proper distribution of light in interiors, and the value of diffused light. 1000 w. Elec Rev, N Y—April 15, 1905. No. 68947.

Lamps.

Modern Arc Lamps. John Howatt. Discusses the requisites of the ideal arc lamp, and the changes and improvements during the last ten years, giving illustrated descriptions of different types. 3000 w. Am Elect'n—April, 1905. No. 68810.

Mercury Vapor.

Principles and Applications of Mercury Vapor Apparatus. F. von Keller. Briefly considers its application in the lamp, the converter, the interrupter and the alternating current switch. General discussion. 5500 w. Pro Engrs' Club of Phila—April, 1905. No. 69033 D.

Nernst.

Notes on the Use of Rare Earths in Electric Illuminants. Murray C. Beebe. Information of interest concerning the mixtures used as glowers in lamps of the Nernst type. 4500 w. Pro Engrs' Soc of W Penn—April, 1905. No. 69039 D.

Titanium Arc.

The Metallic Arc. Isador Ladoff. Reports experiments made with titanium pencils, giving results. Also editorial. 3500 w. Elec Wld & Engr—April 22, 1905. No. 69209.

MEASUREMENT.

Dynamo Testing.

A New Method of Testing Alternating-Current Generators. H. M. Hobart and F. Punga. Describes a method requiring no alterations to the windings and no greater expenditure of energy than is necessary for covering the internal losses. 1200 w. Elec Wld & Engr—April 22, 1905. No. 69210.

Frequency Meters.

The Calibration of Frequency Meters, with Especial Reference to the Slaby Multiplication Scales (Die Eichung von Wellenmessern insbesondere beim Slabyschen Multiplikationsstabe). P. Drude. Describing both the direct and the indirect process of calibration, according to the Slaby method, with tables of instrumental corrections. 3500 w. Elektrotech Zeitschr—April 13, 1905. No. 69152 B.

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Metering.

Some Notes on Polyphase Metering. J. D. Nies. Discusses methods of polyphase metering and the errors that occur, concluding that in metering three-phase systems, three separate single-phase meters make the best arrangement when the highest degree of accuracy is demanded. 4800 w. Am Inst of Elec Engrs—April, 1905. No. 69028 D.

Meters.

Maintenance of Meters. W. J. Mowbray. On the necessity of periodic overhauling to maintain meter accuracy. 1200 w. Am Inst of Elec Engrs—April, 1905. No. 69031 D.

Right Angle Connections, with Especial Reference to the Action of Magnetic Fields (Ueber 90° Schaltungen mit besonderer Berücksichtigung Magnetisch Verketteter Stromverzweigungen). Emil Waltz. An elaborate discussion of the relation of alternating currents and magnetic fields in connection with the design of alternating current meters. Three articles. 12000 w. Elektrotech Zeitschr—March 9, 16, 23, 1905. No. 69143 each B.

Meter Testing.

The Meter Department of the New York Edison Company. Illustrated description of the methods employed to secure accuracy of electricity meters. 2300 w. Elec Wld & Engr—April 1, 1905. No. 68806.

Oscillograph.

A New Oscillograph Wave Tracer. Rudolf Goldschmidt. An illustrated description of the apparatus, explaining the principle. 800 w. Elect'n, Lond—April 14, 1905. No. 69230 A.

Notes on Some Effects in Three-Phase Working. W. M. Thornton. Read before the Newcastle Local Sec. of the Inst. of Elec. Engrs. Gives results of investigations with the oscillograph which were undertaken with the object of deciding questions of importance in the working of a polyphase system. 3300 w. Elect'n, Lond—April 14, 1905. No. 69232 A.

The Oscillograph and Its Uses. Lewis T. Robinson. Outlines the steps that have led to present methods in use for recording the wave forms of electric currents, describing the devices now employed and the uses to which they may be put. Ills. 3500 w. Am Inst of Elec Engrs—April, 1905. No. 69030 D.

Photometer.

On a Scale of Color-Values and a New Photometer. Arthur H. Munsell. An illustrated description of the Munsell photometer, explaining the principle of the instrument, its calibration, and giving directions for its use in measurements of light and color. 4000 w. Tech Qr—March, 1905. No. 69008 E.

Rheostats.

Bimetallic Rheostats. F. Punga. Illustrates and describes a rheostat devised by Mr. Hobart, in which iron and copper are combined. 800 w. Elec Rev, Lond—March 31, 1905. No. 68902 A.

Voltmeter.

An Electrostatic Voltmeter for High Pressures (Ein Elektrostatisches Voltmeter für Hohe Spannungen). A. Grau. Describing a form of electrostatic voltmeter in which oil is used as the dielectric instead of air, and applicable for pressures up to 90,000 volts. 1800 w. Elektrotech Zeitschr—March 23, 1905. No. 69145 B.

Wattmeter.

Single Wattmeter on Edison Three-Wire System. L. A. Freudenberger. Explains the three possible methods of connecting the armature of the recording wattmeter, examining them as to their relative errors. 700 w. Elec Wld & Engr—April 15, 1905. No. 68964.

MOTORS.

Induction Motors.

The Slip of an Induction Motor. B. F. Bailey. Describes the method of measuring the slip which is used in the electrical engineering laboratory of the University of Michigan, which requires only the simplest apparatus and does not involve any change in the connections of the motor. Also editorial. 1700 w. Elec Wld & Engr—April 22, 1905. No. 69208.

Motor Losses.

The Distribution of Losses in Non-synchronous Induction Motors (Verlusttrennung bei Asynchronen Drehstrommotoren). W. Angermann. An analysis of the copper, iron, and friction losses in induction motors, with diagrams showing their distribution. 5000 w. Elektrotech Zeitschr—March 30, 1905. No. 69146 B.

Repulsion Motors.

The Best Arrangement of Windings and Brushes for Compensated Repulsion Motors (Die Günstigste Anordnung von Wickelungen und Bürstenstellungen bei Kompensierten Repulsionsmotoren). Ernst Danielson. An examination of the most efficient windings, with especial reference to the Latour motor. 1500 w. Elektrotech Zeitschr—April 6, 1905. No. 69151 B.

Static Motor.

How to Make an Oscillating Static Electric Motor. Howard B. Dailey. Working drawings and suggestions for the construction of an experimental static motor. 1200 w. Sci Am Sup—April 29, 1905. No. 69256.

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Variable Speed.

Notes on Heating and Sparking Limits in Variable Speed Motors. A. H. Bate. Read before the Birmingham Loc. Sec. Notes the three ways of varying the speed of a shunt motor, the factors that determine the sparking limits, and discusses the way these methods offset the heating and sparking limits. 2500 w. Inst of Elec Engrs—March 15, 1905. No. 69260 D.

TRANSMISSION.

Arresters.

Protective Apparatus. N. J. Neall. An illustrated article explaining static discharges and the equivalent spark gap, and the development of the multi-path arrester. 1800 w. Elec Club Jour—April, 1905. No. 69027.

The Arrangement of Lightning Arresters and the Influence of Choke Coils (Die Schaltung der Blitzableiter und der Einfluss von Drosselspulen). F. Neesen. An examination of various methods of connecting lightning arresters, comparing different designs. 4000 w. Elektrotech Zeitschr—March 30, 1905. No. 69148 B.

Cable Insulation.

The Insulation Resistance of High-Pressure Cables with Impregnated Paper Insulation (Der Isolationswiderstand von Hochspannungskabeln mit Imprägnierter Papierisolation). P. Humann. Data and results of insulation tests on paper covered cables. 1800 w. Elektrotech Zeitschr—March 30, 1905. No. 69147 B.

Long Distance.

Weak Points in Long-Distance Electric Transmission. James C. Bennett. Outlines the nature of the service required for lead-smelting, and some of the problems to be solved, and the trouble arising from interrupted service. 2500 w. Jour Assn of Engng Socs—March, 1905. No. 69046 C.

INDUSTRIAL ECONOMY

Apprenticeship.

The Apprenticeship Question in America. Frank T. Carlton. Discusses briefly the sources from which skilled workers may be drawn; how they are to be trained; and what should be the proportion of apprentices to journeymen. 1600 w. Cassier's Mag—April, 1905. No. 69202 B.

Cost Keeping.

Foundry Cost Accounts. John A. Makens. Read before the Phila. Found. Assn. Discusses the principles involved. 3500 w. Ir Age—April 13, 1905. No. 69020.

Cost Keeping on General Contract Work. A. W. Buel. Mr. Buel's second paper reviews the working systems of several successful contractors with forms and detailed examples of their application. 3500 w. Engineering Magazine—May, 1905. No. 69177 B.

Education.

Trade Schools. Edward Thomas Hewitt. Discusses the value of the trade school in fitting young men for useful lives, the present conditions, the instruction given in various schools, &c. 5000 w. Jour Assn of Engng Socs—March, 1905. No. 69047 C.

Exposition.

The Universal Exposition at Liége, 1905 (L'Exposition Universelle de Liége en 1905). L. Ramakers. A general account of the forthcoming exposition, with plans of the grounds and views of the partially completed buildings. 2000 w. Génie Civil—April 8, 1905. No. 69119 D.

Legislation.

A New and Important Law Affecting Sub-Contractors and Sellers of Material to Parties Holding Government Contracts. An explanation of a recent law passed by the U. S. Congress. 1500 w. Eng News—March 30, 1905. No. 68834.

London Electricity Bills. Considers bills before the English Parliament which are of extreme importance to the electrical industry. 4800 w. Engr, Lond—March 24, 1905. Serial. 1st part. No. 68758 A.

Metal Markets.

The Price Fluctuations of Certain Metals in the Years 1903-1904 (Preisbewegung einiger Metalle in den Jahren 1903 und 1904). B. Neumann. A tabulated view of prices of zinc, tin, lead, and silver for 1903 and 1904, with diagrams giving curves for the continuous price fluctuations. 2000 w. 7 plates. Glückauf—April 8, 1905. No. 69136 B.

Stores.

The Stores System of the National Acme Manufacturing Company. A. W. Henn. A detailed account of the practical working system of a shop making automatic screw machines, with examples of forms and methods. 3500 w. Engineering Magazine—May, 1905. No. 69173 B.

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Tariff.

Machine Tools and the Tariff. Fred A. Geier. Gives information concerning rates in the various countries, and discriminations in some countries against America. 1600 w. Ir Age—April 20, 1905. No. 69005.

Training.

Training of Managers and Foremen at the Royal Ordnance Factories. Memorandum with regard to the report by the Foremen's Qualifications Committee on matters relating to the Royal Ordnance Factories. 1400 w. Mech Engr—April 8, 1905. No. 68983 A.

Works Management.

Machine Shop Management. Oscar E. Perrigo. Describes methods for ascertaining and apportioning the fixed charges, office and salary, and miscellaneous expenses. 5800 w. Ir Trd Rev—April 6, 1905. No. 68780.

MARINE AND NAVAL ENGINEERING

Battleships.

The First-Class Japanese Battleship Kashima. Gives eight pictures, showing the different stages of progress in the building of the ship, with information in regard to it. 2000 w. Engr, Lond—March 24, 1905. No. 68759 A.

Cruisers.

Bids for Scout Cruisers. Gives the bidders and their proposals, with description of the cruisers. 3000 w. Marine Rev—April 20, 1905. No. 69091.

The New Armored Cruiser Washington. Illustrated description of this new vessel, recently launched at Camden, N. J. 1600 w. Naut Gaz—March 30, 1905. No. 68762.

Electric Power.

Electricity as Motive Power for 1,100-Ton Cargo-Boat. J. W. H. Hamilton. Interesting facts relating to the "Vandal," a Russian boat for transportation of oil. Also of a second boat of different design for the same service. 1800 w. Elec Wld & Engr—April 15, 1905. No. 68962.

Exploration Vessel.

The "Discovery." W. E. Smith. Read before the Inst. of Naval Archts. A record of the special features in the design of this Antarctic exploration vessel, describing details of construction. Ills. 8500 w. Engng—April 14, 1905. No. 69236 A.

Launch.

Launch of the Steamship La Provence (Lancement du Faquebot La Provence). A. Dumas. Illustrated description of the launching of a new vessel for the French Transatlantic Line. Displacement 19,160 tons; 30,000 h. p. 1800 w. Génie Civil—March 25, 1905. No. 69116 D.

Motor Boats.

Monaco Motor Boat Meeting. A list of the entered boats, with their characteristics and racing numbers, with illustrated account of the races. 2000 w. Auto Jour—April 15, 1905. No. 69223 A.

The Automobile Boat Hilda. L. Ramakers. Illustrated detailed description of a boat designed for use in the study of the application of internal combustion motors to the propulsion of rapid boats. 1000 w. Marine Engng—April, 1905. No. 68779 C.

The Deep-Sea Cruiser, "Napier Major." Illustrated detailed description. 1200 w. Auto Jour—April 8, 1905. No. 68976 A.

Propeller Shaft.

Repairing a Propeller Shaft. An illustrated account of the repairs executed at sea to the tail shaft of the steamship Milton. 1800 w. Engr, Lond—April 14, 1905. No. 69241 A.

Shallow-Draft.

Design of a Shallow-Draft Boat Driven by Twin-Turbine Propellers. O. Lienau, in *Schiffbau*. An illustrated article explaining method of designing a vessel with a draft not exceeding 16-inches, having a speed of 13 knots in slack water. 2000 w. Marine Engng—April, 1905. No. 68778 C.

Shipbuilding.

Recent Development of Lake Ship Building. Waldon Fawcett. An illustrated article discussing recent vessels for the lakes, and the change of policy made evident in the four new steel steamers under contract. 2200 w. Marine Engng—April, 1905. No. 68777 C.

Steel Shipbuilding in Hongkong. J. W. Graham. Confined to the actual steel portions of a vessel. Discusses the best methods to adopt with Chinese labor to get desired results. Also a description of a new shipbuilding plant at Hongkong. 7700 w. Far-East Rev—Feb., 1905. No. 68738 D.

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Sounding Apparatus.

A Leadless Sounding Apparatus. Dr. Alfred Gradenwitz. Describes an apparatus invented by H. Berggraf, a Norwegian engineer, for determining the depth of water under a vessel and continuously recording it. Ills. 900 w. Sci Am—April 22, 1905. No. 69085.

Steamers.

Side-wheel Passenger Steamer Providence. Illustrated detailed description of a sound steamer to run between Providence and New York. 2900 w. Marine Rev—March 30, 1905. No. 68763.

Steam Turbines.

See Mechanical Engineering, Steam Engineering.

Tugboats.

Modern American Tugboats. Illustrates and describes three fine steel tugboats recently built at Staten Island, N. Y. 1000 w. Naut Gaz—April 20, 1905. No. 69062.

Turbine Liner.

The "Victorian," The First Turbine Atlantic Liner. Brief illustrated description. 900 w. Sci Am—April 8, 1905. No. 68849.

MECHANICAL ENGINEERING

AUTOMOBILES.

Albion.

The 16 H. P. Albion Car. An illustrated detailed description of an interesting car. 900 w. Autocar—April 15, 1905. Serial. 1st part. No. 69225 A.

Balancing.

The Balancing of Petrol Engines. J. C. Crombie. Considers the fundamental principles connected with the balancing of reciprocating engines, showing how far it is possible to balance the different types of motors now in use. Ills. 1800 w. Autocar—April 1, 1905. No. 68900 A.

Classification.

Classes in Competitions and Races. Henry Sturmey. Considers the difficulties of classification, weight versus price, workable classification, and regulations for weighing. 2700 w. Autocar—April 15, 1905. No. 69226 A.

Compound Engine.

The Construction and Working of a Compound Petrol Motor. Edward Butler. Illustrated description of a compound 3-cylinder petrol launch motor made in 1888-9 for the Petrol Cycle Syndicate. 1800 w. Mech Engr—March 25, 1905. No. 68744 A.

Coolers.

Water-Coolers for Motor-Cars. J. S. V. Bickford. An account of experimental investigations giving results at variance with those published by other investigators. 2200 w. Engng—March 31, 1905. No. 68905 A.

Electric Vehicles.

The Future of the Electric Automobile. S. G. Chambers. Abstract of a paper read before the London Automobile Club. Considers the commercial future of the electric carriage in its present form. Thinks the touring car will not be electrically driven, nor the omnibus, nor the hackney cab, but that there still remains a large field. 2000 w. Elec Rev, Lond—March 24, 1905. No. 68750 A.

Exhibition.

Agricultural Hall Show. Illustrates and describes some of the vehicles shown at this London exhibition. 2000 w. Auto Jour—March 25, 1905. Serial. 1st part. No. 68742 A.

Motor Car Show at Islington. A brief review of the more interesting exhibits. 2800 w. Engr, Lond—March 24, 1905. No. 68760 A.

Garages.

Salesrooms and Garages in Paris. Brief illustrated descriptions of showrooms, stores, garages, and their equipment. 4000 w. Automobile—April 15, 1905. Serial. 1st part. No. 68932.

Legislation.

Pennsylvania's New Automobile Law. Full text of compromise automobile license and speed measure passed and signed by Governor Pennypacker on April 19. 1800 w. Automobile—April 22, 1905. No. 69090.

The New British Regulations for the Use of Heavy Motor Vehicles. Gives rules limiting the weight of motor vehicles and fixing the width of tire in proportion to the weight and the wheel diameter. 3000 w. Eng News—April 20, 1905. No. 69078.

Omnibuses.

Gasoline Omnibuses in London. An account of the satisfactory service. 2000 w. Automobile—April 15, 1905. No. 68934.

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Petrol-Electric.

Krieger Petrol Electric Motor-Car. Illustrated description of a car using a dynamo driven by a petrol motor, without any auxiliary battery for the supply of power. 1500 w. Engng—April 7, 1905. No. 68921 A.

Prunel.

The 1905 Prunel Petrol Cars. An illustrated article describing the new features in this year's models. 1200 w. Auto Jour—April 8, 1905. No. 68977 A.

Reliability Trial.

An Australian Reliability Trial. An illustrated detailed description of the run from Sydney to Melbourne, a distance of 572 miles. 2500 w. Auto Jour—April 15, 1905. No. 69224 A.

Tires.

American Pneumatic Automobile Tires. Illustrates and describes types of tires in use, and the arrangements made to meet the severe conditions; the materials and methods of manufacture are also considered. 3000 w. Automobile—April 15, 1905. No. 68933.

Touring Car.

Stoddard-Dayton Four-Cylinder Touring Car. Illustrated detailed description of a car first shown at the Chicago exhibition. 1800 w. Automobile—April 8, 1905. No. 68875.

Wheels.

Road Wheels for Mechanical Vehicles. R. G. L. Markham. Discusses the conditions necessary for a perfectly satisfactory wheel, illustrating and describing devices under trial. 3800 w. Cassier's Mag—April, 1905. No. 69201 B.

COMBUSTION MOTORS.

Caloric Engine.

Svea Caloric Engine. G. Emil Hesse. An illustrated article explaining the working of this engine. 1400 w. Sci Am Sup—April 29, 1905. No. 69257.

Diesel.

The Diesel Oil Engine. Illustrated description of British-built Diesel engines, with account of their development. 1200 w. Engr, Lond—March 31, 1905. No. 68912 A.

Gas Engines.

500 B. H. P. Gas Driven Dynamo Engine. Illustrated description of a double-acting two-cylinder gas engine of the Cockerill type, recently built for the electric station of Middlesbrough works. 800 w. Engr, Lond—April 7, 1905. No. 68994 A.

Gas Engines for Railway and Power Service. Illustrates and describes the two types of engines developed by the Westinghouse Co. and their operation. 2500 w. St Ry Rev—April 15, 1905. No. 69069 C.

Recent German Gas Engines. Prof. E. Meyer. Read before the Verein Deutscher Eisenhüttenleute. Describes some of the recent large gas engines of German makers. Ills. 1200 w. Am Mfr & Ir Wld—April 6, 1905. No. 68729.

The Koerting Four Cycle Gas Engine. F. E. Matthews. Illustrated description of this engine with report of tests. 1600 w. Cent Sta—April, 1905. No. 68865.

The Mechanical Efficiency and Indicated Capacity of the Gas Engine (Der Mechanische Wirkungsgrad und die Indizierte Leistung der Gasmaschine). An exhaustive symposium, to which contributions are made by Stodola, Riedler, Schöttler, Meyer, Ehrhardt, and Wagener. 10000 w. Zeitschr d Ver Deutscher Ing—April 1, 1905. No. 69112 D.

Gas Power.

Gas Producers in Ironworks. Paper read by Herr Otto Wolff before the Assn. of Ironmasters in S.-W. Germany, at Saarbrucken. Explains the principle of gas producers, the requirements of a good producer, and discusses various forms that have stood the test of practical working. Ills. 3000 w. Ir & Coal Trds Rev—April 14, 1905. No. 69242 A.

Power Generation at Coal Mines in Connection with Coke Ovens (Krafterzeugung auf Kohlengruben im Anschluss an Koksöfen). H. Iffland. An examination of the cost of power generated at the mine, including the use of coke-oven gases in gas engines. 3000 w. Glückauf—March 25, 1905. No. 69131 B.

Power Production from Gaseous Fuel. J. R. Bibbins. Read before the Ohio Gas Lgt. Assn. Considers producer gas is to furnish the solution to the power problem, and gives much information in regard to applications. Discussion. 7500 w. Pro Age—April 15, 1905. No. 68914.

Oil Engines.

Some Features in the Design of Oil Engines. Edward Butler. The present article considers engines working with an exhaust heated vaporizer. 1200 w. Mech Engr—April 8, 1905. Serial. 1st part. No. 68982 A.

The Hornsby Vertical Oil-Engine. Illustrated detailed description, with summaries of trials. 1400 w. Engng—March 31, 1905. No. 68908 A.

Suction Gas.

Suction-Gas Plants. F. H. Bowman. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Discusses points to be considered in determining the nature of the plant to be used; the principal forms of producers,

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especially suction-gas producers. Discussion. 4500 w. Elect'n, Lond—April 7, 1905. No. 68988 A.

Suction Gas Producers. The present article discusses the advantages claimed for the suction producer, the types now on the market, some applications, &c. 2700 w. Engr, Lond—March 31, 1905. Serial. 1st part. No. 68910 A.

The Design and Operation of the Suction Gas Producer. Rodolphe Mathot. A practical discussion of the design and best proportions of suction gas producer plants, showing the high efficiency of the apparatus. 3000 w. Engineering Magazine—May, 1905. No. 69172 B.

Waste Gas.

Electric Smelting and Blast Furnace Gases. Auguste J. Rossi. The first part of an article on the utilization of blast furnace gases for the generation of electrical energy for use in the electric furnace. 2000 w. Elec-Chem & Met Ind—April, 1905. Serial. 1st part. No. 68776 C.

The Use of Waste Gases in Gas Engines. Max Rotter. Abstract of an address before the Steel Works Club of Joliet, Ill. Considers briefly coke oven gas, blast furnace gas, governing, &c. 2000 w. Engr, U S A—April 15, 1905. No. 68997 C.

HEATING AND COOLING.

Hot-Air.

Gas as a Fuel for Hot-Air Heating. R. S. Thompson. Read before the Am. Soc. of Heat. & Ven. Engrs. Considers how to use gas successfully and economically in hot-air heating. 2800 w. Can Archt—March, 1905. No. 68740 C.

Hot Water.

Charts for the Steam Fitter. Piping for Hot Water Heating. William G. Snow. The first of a series of charts on piping erection for hot-water and steam systems, with explanatory notes. 300 w. Met Work—April 29, 1905. Serial. 1st part. No. 69272.

N. Y. Stock Exchange.

Heating, Ventilating and Air Cooling at the New York Stock Exchange. Illustrated description of the interesting engineering equipment of this fine building. 2300 w. Eng Rec—April 8, 1905. Serial. 1st part. No. 68896.

Refrigeration.

Electric Power for Refrigeration. J. C. Chamberlain. Illustrated description of an automatic refrigerating plant and its operation. 1700 w. Elec Wld & Engr—April 1, 1905. No. 68807.

HYDRAULICS.

Centrifugal Pumps.

Phenomena of Machine Operation. John Richards. Considers the evolution of apparatus to impel fluids, especially liquids, by centrifugal force, as illustrated by centrifugal pumping turbines, &c., showing that development has often been by studying the conditions of use. 3300 w. Jour Assn of Engng Socs—March, 1905. No. 69048 C.

Hydro-Electric Stations.

See Electrical Engineering, Generating Stations.

Pumping.

See Civil Engineering, Water Supply.

Pumps.

Pump Piping. W. H. Smead. Describes some of the most practical ways of connecting pumps. Ills. 1200 w. Engr, U S A—April 1, 1905. Serial. 1st part. No. 68804 C.

Regulation.

A System of Regulating Centrifugal Fans and Pumps. Aegidius Elling. An illustrated article explaining the system of regulation, and a contrivance for removing the worst drawbacks. 2000 w. Prac Engr—April 7, 1905. Serial. 1st part. No. 68978 A.

Stream Discharge.

See Civil Engineering, Measurement.

Stream Power.

Power Capacity of a Running Stream Without Storage. William G. Raymond. From Pro. of the Iowa Engng. Soc. Shows that for streams on which there is little or no storage, the only proper way to estimate the power available is to estimate it from the daily rather than the monthly flow. 2800 w. Elec Rev, N Y—April 8, 1905. No. 68884.

Valves.

Free Moving Pump Valves (Ueber Freigehende Pumpenventile). L. Klein. Data and results of experimental investigations into the relation of lift to discharge in the case of pump valves free from any mechanical control. 1800 w. Zeitschr d Ver Deutscher Ing—March 25, 1905. No. 69108 D.

MACHINE WORKS AND FOUNDRIES.

Car Wheels.

The New Car-Wheel Foundry of the Pennsylvania R. R. Illustrated detailed description of this new shop at Altoona, Pa., and its equipment. 3000 w. Eng Rec—April 8, 1905. No. 68891.

Case-Hardening.

Case-Hardening. David Flather. Read before the Cycle Engineers' Inst., Bir-

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mingham, Eng. An illustrated article describing the process and the equipment and materials needed. 6000 w. Ir & Steel Mag—April, 1905. No. 69049 D.

Castings.

A Jet Condenser Casting and the Pattern Work for It. Joseph Horner. Illustrated description of patterns and methods used. 1200 w. Am Mach—April 13, 1905. No. 68927.

Making Fine-Surfaced Castings. Walter J. May. Suggestions for obtaining good results. 1500 w. Prac Engr—April 14, 1905. No. 69227 A.

Mending a Casting with Thermit. Patrick Redington. Facts from the writer's experience. 1000 w. Foundry—April, 1905. No. 69018.

Chemistry.

Chemistry in Foundry Practice. N. W. Shed. Read before the Buffalo Found. Assn. On the change in methods brought about by the chemist, and his value, especially in the making of special irons. 1700 w. Foundry—April, 1905. No. 69016.

Science in the Iron Foundry. J. E. Stead. Calls attention to certain necessary conditions for carrying out foundry practice in the present, suggesting lines metallurgical chemists should follow. 5000 w. Ir & Steel Mag—April, 1905. No. 69050 D.

Cores.

Core Room Records. R. W. McDowell. On the importance of keeping accurate cost records for core rooms, explaining a method of keeping records of a radiator plant. 2000 w. Foundry—April, 1905. No. 69017.

Core Sand Binders. J. S. Robeson. Read before the Pittsburg Found. Assn. Considers the work required of a binder, the usual methods of preparing the mixture, and matters related. 4000 w. Foundry—April, 1905. No. 69015.

Cost Keeping.

See Industrial Economy.

Elbow.

Developing a Cylinder Intersecting an Elbow by the Method of Projection. Illustrates and describes the method used in developing the pattern. 1000 w. Boiler Maker—April, 1905. No. 68869.

Electric Driving.

Some Special Applications of Electric Driving (Ueber Einige Elektrische Spezialantriebe). Alfred Kolben. Describing the electric driving of centrifugal sugar separators, of textile machinery, color presses, etc. 4000 w. Zeitschr f Elektrotechnik—April 2, 1905. No. 69155 D.

Systems of Electrical Distribution in Railway Shops. J. Henry Klinck. An illustrated article discussing the system best adapted to railroad repair work. 4500 w. Ry Mas Mech—April, 1905. No. 68872.

The Attachment of Motors to Machine Tools. Illustrates and describes the methods of the Crocker-Wheeler Company. 2800 w. Am Mach—Vol. 28, No. 17. No. 69245.

Flanging.

A Large Cold Flanging Machine. E. A. Suverrop. Illustrated description of a Rochester, N. Y., plant for the manufacture of glass-lined steel tanks. 3000 w. Am Mach—Vol. 28, No. 14. No. 68796.

Lovekin's Pipe-Flanging Machine. Illustrates and describes machinery and tools for putting flanges on copper pipes by means of expansion, in such a way as to make a tight joint, without any brazing. Also applicable to wrought iron or steel pipe. 1800 w. Engng—March 24, 1905. No. 68755 A.

Foundry.

Iron Foundry of the Yale & Towne Mfg. Co., Stamford, Conn. Illustrated article describing a foundry where the entire output is high grade small work. 1000 w. Foundry—April, 1905. No. 69014.

Grinding.

Grinding and Grinding-Machine Rests. Illustrates and describes rests in use, which the writer commends as the best he has seen. 1600 w. Am Mach—Vol. 28, No. 16. No. 69074.

Hardening.

The Brayshaw Salt Bath Hardening Furnace. Emile Guarini. Illustrated description of a furnace designed to effect the hardening of steel articles with a degree of precision hitherto unattained. 1000 w. Ir Age—April 20, 1905. No. 69004.

Hoppers.

A Trough Hopper Intersecting a Truncated Cone. Illustrates and describes the method used. 700 w. Boiler Maker—March, 1905. No. 68866.

Japan.

The Manufacture of Electrical Machinery in Japan. William Dinwiddie. Illustrates and describes the Shibaura Engineering Works and some of their products. Also editorial on the quality and cost. 2800 w. Elec Rev, N Y—April 22, 1905. No. 69095.

Krupp.

The Krupp Works. Emile Guarini. Brief illustrated descriptions of the Krupp establishments in Germany, which

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consist of eight different groups, and employ nearly 150,000 people. 2800 w. Cassier's Mag—April, 1905. No. 69200 B.

Lathes.

A Rapid Production Vertical Turret Lathe. Illustrated description of a new machine for handling heavy face-plate work of all descriptions. 800 w. Ry Mas Mech—April, 1905. No. 68873.

The Automobile Versus the Hand Turret Lathe. P. V. Vernon. A reply to an article by Paul Wesley, followed by an illustrated description of the operation of the automatic machine. 2000 w. Am Mach—Vol. 28, No. 16. No. 69072.

3-In. Flat Turret Lathe with Cross-Sliding Head. Illustrated detailed description. 900 w. Engng—March 31, 1905. No. 68907 A.

Lead Pipes.

The Relative Values of Hydraulic-Drawn and Hand-Made Lead Pipes and Traps. Thomas Daye. Considers the advantages of lead over iron pipes, and the processes of making the drawn and hand-made pipes, concluding that the latter are more likely to be free of impurities, but should be made without a soldered seam. 3500 w. Plumb & Dec—April 1, 1905. No. 68898 A.

Liquid Fuel.

Liquid Fuel for Furnace Equipment. W. N. Best. On the increasing use of liquid fuel and its success in forges and furnaces. 1600 w. Sci Am—April 8, 1905. No. 68850.

Machine Tools.

Machine Tool Design. Prof. J. T. Nicholson, and Dempster Smith. The first of a series of articles offering a new series of rules of design, based upon extensive experiments on cutting with the new steels, and checked by numerical data collected from the most recent practice of machine tool makers. 3300 w. Engr, Lond—April 7, 1905. Serial. 1st part. No. 68992 A.

Proportions of Machine Tool Parts. Thomas R. Shaw. Tables and figures. Mech Engr—April 8, 1905. Serial. 1st part. No. 68980 A.

Melting.

The Melting and Cooling of Foundry Iron. Abstract of an address delivered by R. Buchanan before the Coventry (England) Engineering Society. 1200 w. Am Mach—Vol. 28, No. 13. No. 68787.

Molding.

Molding a Jet Condenser. Joseph Horner. Illustrates and describes the method used. 800 w. Am Mach—Vol. 28, No. 16. No. 69073.

Punching.

Punching Small Holes in Tool Steel Blanks. Joseph V. Woodworth. Illustrates and describes tools used for punching holes 0.050 inch in diameter through steel 1-16 inch thick. 700 w. Mach, N Y—April, 1905. No. 68808 C.

Shop Appliances.

Mechanical Appliances in Iron Works (Maschinelle Einrichtungen für das Eisenhüttenwesen). Fr. Frölich. The first article discusses devices used in connection with the rolling and drawing of tubing. Serial. Part I. 2000 w. Zeitschr d Ver Deutscher Ing—March 25, 1905. No. 69104 D.

Shop Tools and Devices. F. J. Le Card. Illustrated Sketches of tools and appliances useful for purposes stated. 700 w. Am Mach—Vol. 28, No. 15. Serial. 1st part. No. 68925.

Shops.

The New Works of the Ingersoll-Sergeant Drill Company. Illustrated description of extensive shops at Phillipsburg, N. J., for making air-compressors, rock-drills, and coal-cutters. 3800 w. Eng Rec—April 15, 1905. Serial. 1st part. No. 68967.

The Shops of the United Shoe Machinery Co., Beverly, Mass. Illustrated detailed description of shops for the manufacture of light machinery. 2700 w. Eng Rec—April 1, 1905. Serial. 1st part. No. 68826.

Soldering.

How to Make an Electric Soldering Iron. Arthur B. Weeks. Directions, with design, and remarks on its use. 1000 w. Sci Am—April 8, 1905. No. 68851.

Time System.

A Decimal Time System for Factories. Illustrates and describes some devices for time keeping. 1200 w. Am Mach—Vol. 28, No. 16. No. 69071.

Tool Works.

The Plant of the Ridgway Machine Tool Company. Illustrated detailed description of new works at Ridgway, Pa., for the building of high class heavy machine tools. 3500 w. Ir Age—March 30, 1905. No. 68790.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Alloys.

Notes on Engineering Alloys. Ernest A. Lewis. A discussion of alloys used in brass-foundries, giving general rules for the production of good castings. 2200 w. Engng—March 31, 1905. No. 68906 A.

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Brittleness.

The Influence of the Form of Test Piece upon Tests for Brittleness (Influence des Variations de Forme de l'Entaille dans les Essais de Fragilité). F. Barbier. Discussing especially the effect of the shape of the notch upon drop tests on notched bars. 1200 w. Génie Civil—April 1, 1905. No. 69118 D.

Low Temperatures.

The Effect of Liquid Air Temperatures on the Mechanical and Other Properties of Iron and Its Alloys. Sir James Dewar, and Robert Asholt Hadfield. Gives the more important results of a series of tests carried out on some five-hundred specimens of standard iron and iron alloyed with other elements. 4200 w. Sci Am Sup—April 15, 1905. No. 68938.

Patina.

Patina and Its Chemistry. Dr. Otto N. Witt. Showing that rusting and the formation of patina are closely related from the chemist's point of view, and both are caused by the condition of the atmosphere. 2700 w. Sci Am Sup—April 22, 1905. No. 69086.

Testing.

Method of Making Tests on Metals. Dr. A. Gradenwitz. Illustrated description of apparatus, described by M. Guillery in a recent paper for carrying out mechanical tests on metals. 1400 w. Ir Trd Rev—April 6, 1905. No. 68781.

Tool Steel.

The Uses of High-Speed Steel. Remarks on methods of using, treating and grinding high-speed steel. 2000 w. Mach, N Y—April 1, 1905. No. 68809 C.

MEASUREMENT.

Dynamometers.

The Use of Dynamometers. N. Ronneberg. An illustrated description of the manner of using these instruments for measuring power. 2000 w. Mod Mach—April, 1905. No. 68734.

Friction.

The Laws of Sliding Friction (Sur les Lois du Frottement de Glissement). Paul Painlevé. An examination of the laws of Coulomb, showing the influence of the distribution of the pressure upon the friction of two surfaces. 2000 w. Comptes Rendus—March 13, 1905. No. 69122 D.

Gunnery.

A Practical Method of Adjusting a Modern Gun and Determining Its Errors and the Errors of Its Telescopic Sight. Otto von Geldern. Treats the gun in the sense of a mathematical instrument only, and explains a method by which it may be oriented and adjusted, and by which any error in its horizontal or vertical motion may be detected. 4000 w. Eng News—April 13, 1905. No. 68949.

Indicator Springs.

Indicator Springs Subjected to Tension (Auf Zug Beanspruchte Indikatorfedern). R. Schwirkus. Tabulated results of tests on indicator springs made at the Reichsanstalt, showing that there is less trouble from lateral bending with the tension springs than with those under compression. 1800 w. Zeitschr d Ver Deutscher Ing—March 25, 1905. No. 69109 D.

Metric System.

The Metric Fallacy. Frederick A. Halsey. An explanation of the difficulties arising in displacing a system of weights and measures, and why scientific men regard the subject differently than manufacturers. 8500 w. Sib Jour of Engng—April, 1905. No. 69040 C.

Torsion Meter.

Denny and Johnson's Torsion Meter. Illustrated detailed description of instruments by use of which the torsion of revolving shafts may be ascertained, enabling the h. p. transmitted to be accurately calculated. 2500 w. Engng—April 7, 1905. No. 68918 A.

POWER AND TRANSMISSION.

Compressed Air.

Hydraulic Compressed Air in Connecticut. J. Herbert Shedd. Briefly reviews the early uses of compressed air and describes some of the features of an installation for the hydraulic compression of air of a plant in Connecticut. Ills. Discussion. 7000 w. Jour N Eng W-Wks Assn—March, 1905. No. 69052 F.

Cranes.

Electric Crane at the St. Triphon Quarries, Switzerland. C. L. Durand. Illustrates and describes the new electric lifting and conveying apparatus and its working. 1100 w. Elec Rev, N Y—April 1, 1905. No. 68788.

Elevators.

Electrically-Driven Lifts. F. O. Hunt. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. An illustrated article discussing features needing to be improved, and the most suitable type of motor. 1800 w. Elec Engr, Lond—April 7, 1905. Serial. 1st part. No. 68985 A.

Investigations of the Operation of Electric Elevators (Untersuchung des Auslaufweges Elektrischer Aufzüge). Hugo Stahl. With diagrams showing the accelerations, and general action, with various methods of braking and control. 4500 w. Zeitschr d Ver Deutscher Ing—April 8, 1905. No. 69113 D.

We supply copies of these articles. See page 477.

Gearing.

A Spur-Gear Anglemeter. W. M. Wilson. An illustrated descripton of an instrument designed for determining the variation in the angular velocity ratio of gears, explaining its use. 3000 w. Am Mach—Vol. 28, No. 15. No. 68924.

Bevel Gear Formulas. John Edgar. A compilation of a set of formulas that will answer for any case. 1300 w. Am Mach—Vol. 28, No. 15. No. 68926.

Motor Springs.

The Motor Spring and Its Calculation. Emil Riedel. Translated from *Allgemeine Uhrmacher Zeitung*. An explanation of the essential and ruling features of so-called mainsprings. 1700 w. Sci Am Sup—April 22, 1905. No. 69087.

Shafts.

Strength of Shafts and Pins. George A. Lister. Gives formulas and diagrams, explaining method of ascertaining size to fulfil any given conditions. 500 w. Mech Engr—March 18, 1905. No. 68743 A.

STEAM ENGINEERING.

Accidents.

Accidents to Boilers and Engines (Schäden an Dampfkesseln und Maschinen). Notes concerning some recent boiler explosions in Germany, and an illustration of the disastrous effects of a flywheel explosion. 1200 w. Glückauf—March 25, 1905. No. 69132 B.

Boiler Bracing.

Bracing Flat Surfaces. William Horsley. Gives table showing the number of braces required on each head on return tubular boilers, with explanatory notes. 500 w. Boiler Maker—April, 1905. No. 68870.

Boilers.

The Care and Management of Steam Boilers. W. H. Fowler. An illustrated review of the mechanical stokers of various types, discussing their merits. 3000 w. Mech Engr—April 1, 1905. Serial. 1st part. No. 68901 A.

Types of Shell Boilers. R. S. Rodie. Drawing and description of a marine shell boiler of the flue and return tubular type. 1500 w. Boiler Maker—March, 1905. Serial. 1st part. No. 68868.

Clearance.

The Effect of Clearance and Compression of Steam Consumption. C. H. Benjamin. Reviews the results of various experimental investigations. 1200 w. Engr, U S A—April 15, 1905. No. 68996 C.

Coal Testing.

Testing Coals and Lignites at the St. Louis World's Fair. E. W. Parker. Mr. Parker's second paper discusses the tests upon lignites, and the gas-producer and briquetting tests, with numerous important tables. 4500 w. Engineering Magazine—May, 1905. No. 69174 B.

The Advantage of a Scientific Basis for Determining the Value of Fuels. Henry J. Williams. Showing the value of analysis and the calorimeter test, offering suggestions for sampling, and describing a calorimeter perfected by the writer. Also discussion. Ills. 9500 w. Jour N Eng W-Wks Assn—March, 1905. No. 69059 F.

The Calorimetric Testing of Coal. George T. Hanchett. Describes method of conducting a test with very simple apparatus. 2500 w. Am Elect'n—April, 1905. No. 68814.

Corliss Engine.

An Old Corliss Engine. Illustrations, with description, of an engine built in 1851 and erected in 1857, which is still in service and likely to continue working for many years more. 1000 w. Power—April 1, 1905. No. 68793 C.

Fire-Boxes.

To Develop Pattern Sheets for Radial Stayed Fire-Boxes. R. C. Young. Directions for developing the pattern. Ills. 1100 w. Boiler Maker—March, 1905. No. 68867.

Fly Wheels.

The Graphical Determination of Flywheel Weights (Die Graphische Ermittlung des Schwungradgewichtes). F. Wittenbauer. A study in graphical dynamics, showing the method of plotting the varying forces in such a way as to enable the regulating weight to be determined. 4000 w. Zeischr d Ver Deutscher Ing—March 25, 1905. No. 69105 D.

Fuel.

Fuel and Furnaces. Abstracted from *Steam: Its Generation and Use*, published by Babcock and Wilcox, Ltd. Deals from a theoretical point of view, with the utilization of the various kinds of fuel and the form of furnace best suited for their combustion. 1700 w. Col Guard (Sup)—March 31, 1905. Serial. 1st part. No. 68904 A.

Steam Engines.

First Report to the Steam Engine Research Committee. Prof. David S. Capper. Giving results of experiments at King's College, London, on jacketed and unjacketed cylinders. 13300 w. Diagrams. Inst of Mech Engrs—March 17, 1905. No. 68752 D.

Modern Continental Steam Engines. L. Ramakers. Illustrates and describes engines on the Lenz system. 1500 w. Prac Engr—April 7, 1905. No. 68979 A.

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Steam Pipes.

The Arrangement of Steam Pipes. R. T. Strohm. Illustrates and describes methods of providing for expansion and contraction. 2000 w. Am Elect'n—April, 1905. No. 68811.

Steam Turbines.

Computation Tables for Steam Turbines (Abstufungstafel für Dampfturbinen). Donat Banki. A discussion of the determination of the best number of stages to be used in a multistage turbine for any given pressure drop. 2000 w. Zeitschr d Ver Deutscher Ing—March 25, 1905. No. 69106 D.

Mechanical Construction of Steam Turbines and Turbo-Generators. W. J. A. London. Abstract of a paper read before the Manchester Loc. Sec. of the Inst. of Elec. Engrs. Deals with the difficulties met in the successful design of steam turbine machinery. Ills. 5000 w. Elect'n, Lond—March 24, 1905. No. 68751 A.

Multiple Steam Turbines. H. Melencovich. Read before the Inst. of Engrs. & Shipbuilders. On the method of reducing high revolutions and circumferential velocities of steam turbines by passing the steam through a number of turbine wheels arranged in series. 3000 w. Mech Engr—April 8, 1905. No. 68981 A.

Steam Turbine Power Plant at a Poughkeepsie Shop. Illustrated description of a plant furnishing the power and lighting to the works of the De Laval Separator Co., showing space economy, an interesting system of steam piping, and other unusual features. 2500 w. Eng Rec—April 22, 1905. No. 69214.

The Steam Turbine Power Station at St. Ouen (Das Dampfturbinen Kraftwerk St. Ouen). Ludwig Troske. A very complete account of one of the power houses on the Paris Metropolitain, in which steam-turbine generating sets are used exclusively. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—April 1, 8, 1905. No. 69111 each D.

Turbines vs. Reciprocating Engines in Marine Service. Discusses the comparative results of the two methods, as shown by the "King Edward" and "Queen Alexandra." 1200 w. Sci Am—April 8, 1905. No. 68848.

Working Results of a Steam Turbine Plant. Gives interesting figures relating to the turbine plant at the new Neepsend generating station of the Sheffield Corporation. 600 w. Mech Engr—March 25, 1905. No. 68747 A.

Superheating.

Superheated Steam. A. G. Gibson. Read before the Owens College Engng. Soc. Briefly reviews the history of superheating, and considers superheating as applied to steam engines or steam turbines. 3700 w. Mech Engr—March 25, 1905. Serial. 1st part. No. 68746 A.

Superheated Steam in Pumping Engines. E. H. Foster. Reviews the results of various tests made, and gives information of interest showing the advantages of superheating. Ills. 3500 w. Jour N Eng W-Wks Assn—March, 1905. No. 69058 F.

The Promise of Superheaters. Editorial discussing steam superheaters for locomotives. 1700 w. Ry & Loc Engng—April, 1905. No. 68785 C.

The Transfer of Heat in the Heizmann Superheater (Wärmedurchgangsversuche mit dem Dampfüberhitzer von Heizmann). Dr. Otto Berner. Data and results of experimental tests of the transfer of heat in superheaters, both in the smoke flue and when independently fired. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—March 25, April 8, 1905. No. 69103 each D.

Vacuum.

High Vacuum Condensing Plants. Ernest Kilburn Scott. Discusses condensers arranged on what is known as the contra flow principle. 1200 w. Aust Min Stand—March 22, 1905. No. 69220 B.

The Effect of Vacuum on Steam-Engine Economy. R. M. Neilson. The first of two articles, discussing the important influence of vacuum upon the economical performance of steam engines and steam turbines. 3500 w. Engineering Magazine—May, 1905. No. 69175 B.

Valve Gear.

Studies in the Heusinger Valve Gear (Untersuchungen an der Heusinger Steuerung). W. Pfitzner. An examination of the so-called Heusinger, or Walschaert type of radial valve gear, extensively used on Continental locomotives. 2000 w. Zeitschr d Ver Deutscher Ing—March 25, 1905. No. 69107 D.

Waste Steam.

Utilizing Waste Steam in Shops. Illustrated description of the method adopted in the Grand Trunk shops, in Montreal. 1300 w. Ir Age—April 27, 1905. No. 69244.

Water Softening.

Notes on Softening and Purification of Water for Steam Raising. Louis J. Le Clair. Read before the Dublin Loc. Sec. of Inst. of Elec. Engrs. On methods of treatment for the softening and the purification of boiler water. 3500 w. Elec Engr, Lond—April 21, 1905. No. 69328 A.

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MINING AND METALLURGY

COAL AND COKE.

Analysis.

The Technical Analysis of Mineral Coal. Dr. J. Ohly. Describes methods in making the determinations. 2000 w. Min Rept—April 6, 1905. No. 68878.

Anzin.

The Anzin Mining Company and its New Arenberg Shaft (Die Bergwerksgesellschaft Anzin und Ihre Neue Schachtanlage Arenberg). An account of the recent developments of one of the oldest and most important coal mining districts of France. 4000 w. Glückauf—April 8, 1905. No. 69135 B.

Bituminous.

Bituminous Coal Washing. L. A. Harding and G. R. Delamater. Illustrated article describing various methods employed. 4300 w. Mines & Min—April, 1905. Serial. 1st part. No. 68863 C.

Briquettes.

Briquetting Fuel. George E. Walsh. An account of this industry in Europe and America. Min Rept—April 13, 1905. No. 68959.

Coal Basin.

The Coal Basin of the Meurthe-et-Moselle (Le Bassin Houiller de Meurthe-et-Moselle). Describing the conclusions drawn from borings in Lorraine, showing the extensive deposits of coal at depths of 250 to 600 metres. 2500 w. Génie Civil—April 8, 1905. No. 69120 D.

The Coal Explorations in Meurthe-et-Moselle (Sur les Recherches de Houille en Meurthe-et-Moselle). R. Nicklès. An account of the borings at Eply, Lesménils and Pont-à-Mousson, in the department of Meurthe-et-Moselle, resulting in the discovery of a workable coal basin. 1200 w. Comptes Rendus—March 27, 1905. No. 69125 D.

The Discovery of Coal in Meurthe-et-Moselle (Sur la Découverte de la Houille en Meurthe-et-Moselle). C. Cavallier. An account of the successful borings in the vicinity of Pont-à-Mousson, with a description of the geology of the district. 1000 w. Comptes Rendus—March 27, 1905. No. 69124 D.

Coal Lands.

The Coal Mines on the West Side Belt Railroad. Samuel Sanford. An illustrated account of these coal lands near Pittsburg, and their development. 4700 w. Eng & Min Jour—April 6, 1905. No. 68799.

Coal Testing.

See Mechanical Engineering, Steam Engineering.

Coke.

A Coking Coal in Chihuahua. William B. Phillips. Describes this seam of coking coal, giving information of its coking quality. 900 w. Eng & Min Jour—April 6, 1905. No. 68802.

Coke Ovens.

Electrically-Served Semet-Solvay Coke Plant at the Works of the Wigan Coal & Iron Company, Limited. Illustrates and describes a battery of forty-four coke ovens installed to secure a more economical supply of coke for use in the blast furnaces of this company. 2500 w. Ir & Coal Trds Rev—April 7, 1905. No. 68990 A.

Colorado.

Disturbances and Other Peculiarities of the Northeastern Coal Field of Colorado Between Ralston Creek and Boulder. A. Lakes. Illustrated description of the geology of these coal-fields, unusually complicated by folds and faults. 1800 w. Min Rept—March 30, 1905. No. 68771.

The Grand River Coal Field. A. Lakes. Describes this largest field in Colorado, which contains a greater variety of coals than any other in the State. Ills. 1300 w. Min Rept—April 13, 1905. No. 68961.

The Yampa Coal Field of Routt County, Colorado. A. Lakes. Brief description of this field which contains the largest area of workable anthracite known in the State. Ills. 900 w. Min Rept—April 20, 1905. No. 69097.

Conveying.

A New Coal-Loading Plant at Lorain, O. An illustrated description of a coal shipping plant, explaining the conditions to be met. 1500 w. Eng News—April 20, 1905. No. 69079.

Mechanical Coal Conveying at the Face. Abstract of a paper by H. Palmer, *Jour. Brit. Soc. of Min. Students.* Illustrated notes on the construction and management of an underground conveying system, patented by W. C. Blackett. 1300 w. Col Guard—April 7, 1905. No. 68915 A.

Peat.

Peat Fuel Works at Chelsea, Mich. D. Bennett. An illustrated description of the methods used in preparing the peat for market. 700 w. Engr, U S A—April 1, 1905. No. 68803 C.

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Preparation Plant.

The Electrically-Driven Preparation Plant of the Dalbusch Mines (Untersuchung der Elektrisch Betriebenen Aufbereitungs-Anlagen auf Zeche Dahlbusch III-IV-VI). A general account of the results of tests of an electrically-driven coal cleaning and washing plant, with tables and diagrams showing power consumption. 6000 w. Glückauf—March 31, 1905. No. 69133 B.

Washington.

Mt. Rainier Coalfields. George S. Rice. Information concerning those fields especially interested in the coast trade and tributary to the ports of Seattle and Tacoma. 1500 w. Eng & Min Jour—April 6, 1905. No. 68801.

COPPER.

Arizona.

The Globe District of Arizona. Brief illustrated description of an interesting copper district. 800 w. Min & Sci Pr—April 15, 1905. No. 69204.

Cyanidation.

Ammonia Cyanidation of Copper. A. Jarman and E. Le Gay Brereton. Abstract from Pro. of the Inst. of Min. & Met. Describes experiments made with the object of finding some solvent possessing a more highly selective action for gold in the presence of copper carbonate that is possessed by potassium cyanide itself. Gives conclusions. 2200 w. Eng & Min Jour—April 27, 1005. No. 69265.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Japan.

The Besshi Copper Mine, Shikoku, Japan. C. J. Davidson. From a report to the Foreign Office. Gives the location, geological formation, description of mine, methods, ore handling, and reduction works in the present number. 3500 w. Min Jour—April 15, 1905. Serial. 1st part. No. 69222 A.

Mexico.

The Mines of Cananea, Mexico. An illustrated description of these mines, chiefly valuable for copper. 1000 w. Min & Sci Pr—April 1, 1905. Serial. 1st part. No. 68879.

Smelting.

Metallurgy of Copper. Horace J. Stephens. An interesting discussion of the methods of copper refining. 5500 w. Ores & Metals—April 15, 1905. No. 68989.

Wyoming.

Blister Copper, 99 Per Cent. Pure. C. R. Stegemann. An illustrated account of the Ferris-Haggarty mine, and its operation. 1500 w. Min Wld—April 15, 1905. No. 68957.

GOLD AND SILVER.

Arizona.

The Tombstone District of Arizona. An illustrated account of this region, describing the deposits carrying values in gold. 2800 w. Min & Sci Pr—March 25, 1905. No. 68770.

Bohemia.

The Mine Workings at Katharinaberg in Bohemia (Der Erzbergbau zu Böhmisch-Katharinaberg im Erzgebirge). Viktor Zeleny. A general account of the geology of the district, lying between the frontiers of Bohemia and Saxony. The ore is a copper glance containing silver. Two articles. 1 plate. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 18, 25, 1905. No. 69137 each D.

Concentrates.

Treating Concentrates by Pan Amalgamation at the Minas del Tajo, Mexico. A. E. Drucker. Describes a process for working fresh or oxidized concentrates. 2700 w. Min & Sci Pr—April 15, 1905. No. 69205.

Concentration.

Notes on Concentrating Mills. Alfred Harvey. Illustrates and describes a typical arrangement of samplers, crushing, and sizing machinery in a modern gold and silver concentrating mill. 1800 w. Mines & Min—April, 1905. No. 68826 C.

Cyanide.

Cyanidation in the South. Herbert A. Megraw. Describes the installation at the Iola mine in North Carolina, and the application of the process used to Southern low-grade ores. Ills. 2200 w. Eng & Min Jour—April 13, 1905. No. 68930.

Dredging.

Dredges for Working Gold-Bearing Gravels. Illustrated description of a dredge recently built for use in California, with some account of this method of working. 1700 w. Eng News—April 27, 1905. No. 69249.

Gold Dredging in Oroville District, Cal. L. J. Hohl. Abstract from the Trans. Cal. Min. Assn. An account of this method of working auriferous gravel deposits, giving illustrated description of dredgers and general features of different types. 3000 w. Min & Sci Pr—April 15, 1905. Serial. 1st part. No. 69203.

Recent Dredging Practice in Australia and New Zealand. H. L. Lewis. The present article considers buckets v. pumps in dredging, and hints on prospecting. 2800 w. Min Jour—April 1, 1905. Serial. 1st part. No. 68903 A.

Ecuador.

Mining in Ecuador. Harry O. Robinson. Information in regard to the development of mining. The values of the ores are mostly in gold. 2000 w. Min Wld—April 1, 1905. No. 68737.

Mexico.

Rich Old Mines of Sonora. E. F. Nichols. Information of interest relating to these old mines yielding gold, silver, quicksilver and other ores. Map. 3200 w. Min Wld—April 1, 1905. No. 68736.

The Sahuayacan District, Mexico. Rufus M. Bagg, Jr. An illustrated article describing the gold and silver mines of the region. 1400 w. Eng & Min Jour—April 20, 1905. No. 69064.

Nevada.

The Walker River District, Nevada. Dwight T. Smith. Describes the ore deposits which carry copper and gold, the geology, &c. 1800 w. Min & Sci Pr—March 25, 1905. No. 68768.

Ore Deposits.

The Yankee Girl Orebody. T. E. Schwarz. Illustrated description of the deposits of silver and copper at Red Mountain, near Ouray, Colorado, discussing the interesting features. 1100 w. Eng & Min Jour—April 27, 1905. No. 69264.

Precipitation.

Precipitation of Gold from Cyanide Solutions. W. J. Sharwood. Abstract of a paper read before the California Miners' Assn. Briefly describes different methods of precipitation in use, discussing results. 2500 w. Eng & Min Jour—April 20, 1905. No. 69065.

Queensland.

Gold, Platinum, Tinstone and Monazite in the Beach Sands on the South Coast of Queensland. Lionel C. Ball. With appendices on the beach sands of New South Wales, and the physical properties, sources, and uses of platinum. Ills. 5700 w. Queens Gov Min Jour—Feb. 15, 1905. No. 68741 B.

Mount Morgan Gold Mine (Q.). E. J. Dunn. Read at meeting of the Royal Society of Victoria. The present article describes the structure of the mine. 2000 w. Aust Min Stand—March 22, 1905. Serial. 1st part. No. 69219 B.

South Africa.

South African Methods. Thomas H. Leggett. Abstract of an address before the California Miners' Assn. On the methods of mining, especially the deep-level properties ,labor, costs, &c. 2700 w. Eng & Min Jour—April 20, 1905. No. 69066.

South Dakota.

The Metallurgical Practice in the Black Hills, South Dakota. Charles H. Fulton. Describes the development of the processes now used. 6800 w. Mines & Min—April, 1905. No. 68858 C.

Stamp Mills.

Stamp Mill Capacity. Discusses methods that have been tried to reach the maximum of capacity with the minimum of loss. 1900 w. Min & Sci Pr—April 15, 1905. No. 69206.

Sudan.

The Possibilities of the Sudan as a Gold Field. W. Broadbridge. Gives the writer's impressions from inspecting several groups of old mines. 2000 w. Min Jour—April 15, 1905. No. 69221 A.

IRON AND STEEL.

Blowing Engines.

Kennedy's Piston Inlet and Outlet Air-Valves for Blowing-Engines. Illustrates and describes four recently installed engines with air-valves of the Kennedy patent horizontal piston type. 900 w. Engng—April 14, 1905. No. 69237 A.

Charging Machine

The Backlund - Burman Traveling Charging Machine for Blast Furnaces. Illustrated detailed description of this apparatus and its working. 1800 w. Ir Age—April 13, 1905. No. 69019.

Dry Air Blast.

Dry Air in the Blast Furnace. A collection of comments from technical papers on the experiments of Mr. Gayley. 7000 w. Ir & Steel Mag—April, 1905. No. 69051 D.

Gayley's Dry Air Blast. F. A. Willcox. Gives results obtained in working out the heat balance of the Isabella and the Lucy furnaces with dry and normal blast, with explanatory remarks. 2300 w. Ir & Coal Trds Rev—March 31, 1905. No. 68913 A.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Hematite.

Brown Hematite Ores. W. R. Crane. On the methods of prospecting, mining, and washing the soft iron ores of the Birmingham district, Alabama. Ills. 4500 w. Mines & Min—April, 1905. No. 68857 C.

Sea Barrier.

Sea Barrier at the Hodbarrow Mines. Illustrated description of a barrier 7,000 ft. long, built in a semi-circular line from shore to shore in order to exclude seawater so that rich iron deposits may be mined. 1800 w. Engng—April 7, 1905. No. 68916 A.

We supply copies of these articles. See page 477.

Separation.

Notes on the Magnetic Separation of Scrap Iron from Mined Ore. J. P. Ward. On the need of a mechanical sorter, suggesting a method. 1600 w. Jour S African Assn of Engrs—Dec., 1904. No. 68735 F.

MINING.

Drilling.

Diamond Drilling from the Bottom of a 2,500 ft. Shaft Full of Water. S. C. Thomson. Describes the method of carrying out the work. Plate. 1400 w. Jour S African Assn of Engrs—Jan., 1905. No. 68899 F.

Electric Power.

Electricity Applied to Mining in California. Describes and illustrates mines in Mariposa County, giving a description of the electric equipment of the Mariposa Commercial & Mining Co. as a typical example of an independent plant. 1800 w. Min & Sci Pr—April 8, 1905. No. 68958.

Electricity in Coal Mining. W. B. Clarke. On the applications made of the electric motor and its especial adaptability for such work. Ills. 1800 w. Min Mag—April, 1905. No. 69043 C.

Electricity in the Anthracite Coal Mines. Robert Thurston Kent. Illustrates and describes applications of electricity in the coal mines. 5300 w. Elec Rev, N Y—April 8, 1905. Serial. 1st part. No. 68882.

Explosions.

Explosions in Kansas. Report of Commission on the causes of recent explosions in coal mines of southeastern Kansas. 2500 w. Mines & Min—April, 1905. No. 68861 C.

Explosive Rock. J. B. Jaquet. An account of the phenomena and discussion of the causes. 2000 w. Eng & Min Jour—March 30, 1905. No. 68797.

Peabody Coal Mine Explosion at Sherman, Ill. Richard Newsam. An illustrated account of an explosion caused by excessive use of powder. 2000 w. Mines & Min—April, 1905. No. 68860 C.

Firedamp.

Notes on the Investigation of Fire Damp (Beiträge zur Untersuchung der Grubenwetter). R. Nowicki. An examination of the application of laboratory methods of gas analysis to the study of samples of explosive gases taken from mine workings. 3500 w. Glückauf—March 18, 1905. No. 69129 B.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Mine Cars.

Types of Mine Cars. R. V. Norris. Illustrates and describes general types in use in the Pennsylvania coal mines. 1000 w. Eng & Min Jour—April 27, 1905. No. 69261.

Mining Industry.

Practical Mining. Abstract of a paper read before the Mining Assn. Discusses points of importance to a successful mining man. 2800 w. Cal Jour of Tech—Feb., 1905. No. 69022 C.

Mining Law.

A Proposed Amendment of the Mineral Land Laws. George A. Packard. Gives the amendment suggested, discussing the advantages of the change. 4500 w. Eng & Min Jour—April 27, 1905. No. 69262.

Ore Deposits.

Metasomatic Replacement. James Park. Explains this term as defined by geologists and discusses the probability of its playing an important part in the formation of mineral veins and ore bodies. 1500 w. Eng & Min Jour—April 27, 1905. No. 69263.

Ore Dressing.

The Ferraris Waving Screen. Charles Will Wright. Explains the principle of the Ferraris system of sizing ores, which is practically unknown in the United States, but can be introduced at small expense. Ills. 1400 w. Min Mag—April, 1905. No. 69044 C.

Rolls.

Springs on Crushing Rolls. Lewis Searing. Considers the disadvantages of the spring rolls, and the superiority of rigid rolls. 900 w. Eng & Min Jour—April 6, 1905. No. 68800.

Safety Lamps.

Safety Lamps for Belgian Coal Mines. A summary of experiments undertaken to show that certain regulations for the use of safety lamps at Belgian coal mines were no longer needed and should be repealed. Also discusses the comparative merits of different types of lamps. Ills. 4000 w. Eng & Min Jour—April 20, 1905. No. 69063.

Some Notes for Effecting Economy in the Use of Safety-Lamp Oil. Ellis Barraclough. Read before the Nat. Assn. of Col. Mgrs. Describes an improvement that makes it possible to use cheaper oil, and yet secure better illumination. 2000 w. Ir & Coal Trds Rev—March 24, 1905. No. 68753 A.

Shafts.

Notes on Vertical Shaft-Sinking on the Witwatersrand. H. Fraser Roche. On the methods employed for sinking vertical shafts by machinery, describing an ideal method. 4000 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1905. No. 68922 E.

We supply copies of these articles. See page 477.

The Kind-Chaudron Method of Shaft-Sinking. L. Ramakers. Illustrates and describes this method, which is particularly applicable to sinking through strata where there is a great influx of water. 1300 w. Min Mag—April, 1905. No. 69042 C.

Timbering.

Anthracite Timbering. Abstract of an article by a practical timberman of twenty-five years' experience. Ills. 2700 w. Mines & Min—April, 1905. No. 68864 C.

The Strength and Life of Mine Timbers. W. H. Storms. Abstract from Trans. Cal. Min. Assn. Notes applying to the Pacific Coast, where only Pacific Coast timbers are used, concerning the timbers best suited to meet the requirements. 1800 w. Min & Sci Pr—April 15, 1905. Serial. 1st part. No. 69207.

Tipples.

Dumping Devices. W. R. Crane. Illustrates and describes dumping devices largely employed in discharging the contents of cars. 2000 w. Eng & Min Jour—April 13, 1905. No. 68929.

Turntable.

Turntable for Inclined Railway (Schwenkbuhne für Geneigte Bahnen). H. Best. Illustrating a form of tilting turntable to enable cars to be transferred from an inclined track to a horizontal one at right angles. 2000 w. Glückauf—March 18, 1905. No. 69130 B.

Winding.

Electric Winding Engine of the Tiremande Mine. Dr. A. Gradenwitz. Illustrates and describes an engine designed for winding 105 tons of coal per hour, from a depth of 400 m., at a speed of 8 m. per second. 1400 w. Elec Rev, Lond—April 14, 1905. No. 69228 A.

On the Electric Drive of Large Reversing Engines Working Intermittently. Maurice Georgi. A comparison of the advantages of electric power over steam for mine hoisting engines. Serial. Part I. 2400 w. Col Guard—April 14, 1905. No. 69235 A.

Winding Engines. W. F. Dam. Considers winding engines generally, and particularly for depths exceeding 1,000 feet, with parallel drums. 8000 w. Mines & Min—April, 1905. No. 68859 C.

MISCELLANY.

Corundum.

Corundum. John L. Cowan. Information as to where found, the production, varieties, preparation for market, &c. 1400 w. Engr, U S A—April 15, 1904. No. 68998 C.

Diamonds.

The Great Premier Diamond. Concerning the mammoth gem recently found in South Africa, with illustrations showing the actual size of the 18 largest diamonds in the world. 1600 w. Sci Am—April 8, 1905. No. 68853.

Nickel.

Treatment of Nickel Ores. Alfred Ernest Barlow. Excerpt from report of the Geological Survey of Canada. Discusses the production of nickel and copper from a sulphide ore. 2500 w. Min Wld—April 15, 1905. No. 68956.

Petroleum.

Oil Fields of the Texas-Louisiana Coastal Plain. N. M. Fenneman. Discusses the location, present condition, and outlook of these fields, their geological structure, the business methods, &c. Ills. 4000 w. Min Mag—April, 1905. No. 69041 C.

The Auditing of Ore Reserves. Discussion of paper on this subject by B. J. Collings. 5700 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1905. No. 68923 E.

The German Petroleum Industry (Die Deutsche Erdölindustrie). H. Michels. A comparative review of the production of petroleum in various parts of the world, and a discussion of the character of the various oils and their products. Serial. Part I. Glückauf—April 8, 1905. No. 69134 B.

Precious Stones.

The Precious Stone Industry of the United States. Elizabeth A. Reed. Information in regard to the precious stones found and the localities. 2500 w. Sci Am Sup—April 8, 1905. No. 68856.

Sulphur.

The Vesuvius of America. Day Allen Willey. An illustrated article describing the sulphur mining industry, and giving an interesting account of its history. 1200 w. Sci Am—April 22, 1905. No. 69084.

Tantalum.

The Occurrence of Tantalum Minerals. David T. Day. On the places where tantalum ore is found in the United States, and on the composition of the ores. 1400 w. Elec-Chem & Met Ind—April, 1905. No. 68772 C.

Tin.

Hints to Aid the Identification of Stream Tin. Charles H. Walker. Suggestions aiding in recognizing cassiterite, the mineral from which metallic tin is principally produced. 1200 w. Min & Sci Pr—March 25, 1905. No. 68769.

Tin Deposits in Alaska. Advance abstract of the geological survey report, prepared by Arthur J. Collier, on developments in 1904. 2000 w. Ir Age—April 6, 1905. No. 68792.

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Zinc.

Cadmium in Spelter. W. R. Ingalls. On the amount found and its influence, and related information. 1400 w. Eng & Min Jour—April 13, 1905. No. 68928.

Zinc Mining and Smelting in Southwestern Virginia. Edwin Higgins, Jr. A description of operations as carried out in this region. 1800 w. Eng & Min Jour—March 30, 1905. Serial. 1st part. No. 68798.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

British Railways.

Methods of Operating English Railways (Betriebseinrichtung der Englischen Eisenbahnen). Prof. Cauer. A fully illustrated account of British railway terminals and methods of operation, in the light of German observation. Serial. Part I. 4000 w. 1 plate. Glasers Annalen—April 1, 1905. No. 69126 D.

Japan.

Japanese Railways. A. R. Bell. An illustrated article giving information of interest in regard to the railway development and service. 2000 w. Ry & Loc Engng—April, 1905. No. 68782 C.

Train Speeds.

The Swiftest Trains in Europe and America (Die Schnellsten Züge in Europa und Amerika). Arnold Kramer. A tabulated comparison of standard trains on the principal railways of England, France, and the United States. 2000 w. Glasers Annalen—April 1, 1905. No. 69127 D.

MOTIVE POWER AND EQUIPMENT.

Benzine Locomotive.

The Work of the Oberursel Benzine Locomotive at the Karawanka Tunnel (Die Oberurseler Spiritus-Benzin-Lokomotive beim Bau des Karawankentunnels). An illustrated account of the use of locomotives using benzine motors, as applied to contractors' work on the Karawanka tunnel in the Tyrol. 1800 w. Glasers Annalen—April 1, 1905. No. 69128 D.

Car Wheels.

See Mechanical Engineering, Machine Works and Foundries.

Cars.

50-Ton Mineral Wagons on French Railways. Illustrated descriptions of types of high-capacity mineral wagons. Also a bogie truck for passenger carriages is shown. 500 w. Engng—April 7, 1905. No. 68917 A.

Steel Underground Gondolas for the B. & O. Illustration, drawings and description of drop-end gondolas of 100,000 lbs. capacity. 500 w. R R Gaz—Vol. XXXVIII, No. 15. No. 68942.

The Capacity of Freight Cars (La Capacité des Wagons à Marchandises). E. Biard. A discussion of the relation of the size of cars to traffic efficiency, with especial reference to the increasing capacity of cars in the United States, compared with other countries. 9000 w. 1 Plate. Mem Soc Ing Civ de France—Jan., 1905. No. 69163 G.

Couplers.

Automatic Couplers (Attelage Automatique). M. Boirault. An illustrated description of the improved automatic coupler designed for use on the State Railways of France. 2500 w. Revue Technique—March 25, 1905. No. 69141 D.

Electric Locomotives.

See Street and Electric Railways.

Electrification.

The Parting of the Ways—From Steam to Electricity. Discusses the important changes from steam to electric traction in progress on the New York Central Railroad near New York. Illustrates the latest steam locomotive and the new electric locomotive for the express service on this road. 1600 w. Sci Am Sup—April 8, 1905. No. 68854.

Locomotives.

A Unique Railroad Relic. Illustration, with description of the "Novelty," one of three engines which competed at the famous trial of locomotives at Rainhill, Lancashire, in Oct., 1829. 1200 w. R R Gaz—Vol. XXXVIII, No. 15. No. 68943.

Balanced Compound for the New York Central. Illustrated description of a 4-cylinder balanced compound of the Vauclain type. 300 w. Ry Age—March 31, 1905. No. 68767.

Engine Failures—Use Both Injectors Regularly. J. W. Reading. Remarks on the feeding of boilers, and faulty practice. 1000 w. Ry & Loc Engng—April, 1905. No. 68784 C.

Foreign Tank Locomotives. Illustrated descriptions of types. Also editorial calling attention to difference in practice in

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Europe and America. 1800 w. Ry Age—April 21, 1905. No. 69093.

Possible Improvements in Locomotive Design. Walter Longland. Read before the Jr. Inst. of Engrs. Examines the structure and working of a locomotive and describes structural alterations proposed to effect improvements. 4000 w. Mech Engr—March 25, 1905. No. 68745 A.

Setting the Frames. James Kennedy. Remarks on the construction of engines, and especially the treatment of the frames. 1700 w. Ry & Loc Engng—April, 1905. No. 68783 C.

The New Express Locomotives of the Bavarian State Railways (Die Neuen 2-5 und 3-5 Gekuppelten Schnellzug-Lokomotiven der Bayerischen Staatsbahnen). E. Weiss. Illustrating and describing heavy compound four-cylinder express engines by Maffei, of Munich. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—March 18, 1905. No. 69100 D.

Two-Cylinder Compound for the "Soo" Line, with Superheater. Illustrated description of a consolidation engine with the Schenectady superheater. 600 w. Ry Age—April 14, 1905. No. 68940.

Locomotive Tests.

Locomotive Tests at St. Louis. Extract from Bulletin No. 4 published by the Penn. Ry. Co., describing tests of Pennsylvania Railroad consolidation locomotive No. 1499. Ills. 4500 w. R R Gaz—Vol. XXXVIII, No. 14. No. 68819.

Lubricator.

Automatic Lubricator for Air Cylinder of Air Pump. T. M. Henderson. Drawings and description of a lubricator for air brake pumps. 700 w. Ry & Loc Engng—April, 1905. No. 68786 C.

Motor Cars.

A New Gasoline Electric Motor Car. Illustrated description of a car deriving its motive power from a four-cylinder gasoline engine of the marine type, direct connected to a direct-current generator, which supplies current to four 35 h. p. motors mounted on the trucks. 1400 w. Ry & Engng Rev—April 8, 1905. No. 68880.

Self-Propelled Passenger Coach. Illustration, with brief description of a car equipped with six-cylinder standard gasoline engine for local traffic at Portland, Ore. 600 w. Automobile—April 1, 1905. No. 68761.

The Daimler Petrol Automobile Car (Automotrice à Pétrole Daimler). R. Bonnin. Illustrated description of a passenger car for main-line local traffic, propelled by a Daimler internal-combustion motor. 1200 w. Revue Technique—March 25, 1905. No. 69138 D.

The Use of Automobile Vehicles on Railways (Emploi des Voitures Automobiles sur les Lignes de Chemins de Fer). F. Barbier. Notes concerning the use of self-propelled cars in various countries for local traffic on main-line railways. 2000 w. Génie Civil—March 18, 1905. No. 69115 D.

Rolling Stock.

Suburban Equipment. Illustrates and describes the new locomotives and coaches put in service on the Chicago & Western Indiana R. R. 1200 w. Ry & Engng Rev—April 22, 1905. No. 69099.

Tipping Car.

Fifteen-Ton Tipping Car (Kippwagen von 15 t. Tragfähigkeit). Illustrating an improved tipping car for sand, gravel, etc., arranged with the ordinary hook coupling as well as the Janney type of coupler. 800 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 1, 1905. No. 69110 D.

Tires.

Tire Wear and Tire Turning. F. W. Williams. Illustrates and describes styles of radius calipers for determining which tire has worn the shortest measurements from the center of the axle. Discussion. 3000 w. Pro Cent Ry Club—March 10, 1905. No. 69001 C.

Unloaders.

Railway Tipping Unloaders (Eisenbahnwagenkipper). Fr. Frölich. Describing a tipping platform for immediate unloading of car loads of sugar beets. 1200 w. Zeitschr d Ver Deutscher Ing—March 18, 1905. No. 69101 D.

Vibration.

New Apparatus for Recording the Vibration of Railway Cars. Emile Guarini. An illustrated description of the Sabouret apparatus and its working. 1400 w. Sci Am Sup—April 29, 1905. No. 69258.

Wheel Pressures.

Safe Limits of Working Load for Wheel Pressures. Tabulating the safe pressures for various diameters and surfaces for car wheels and for small roller bearings. 1800 w. Eng News—April 20, 1905. No. 69082.

NEW PROJECTS.

Africa.

The Uganda Railway Report. Information from this report concerning the railway, and steamboat service on Lake Victoria. 1800 w. Engr, Lond—April 14, 1905. No. 69239 A.

New Line.

The New Chicago-St. Louis Line of the Chicago & Eastern Illinois Ry. Describes a new line opened for traffic Sept. 1, 1904. 2300 w. Eng News—April 6, 1905. No. 68842.

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Simplon Routes.

Connecting Routes to the Simplon (Les Voies d'Access au Simplon). Paul Olivier. With map showing existing lines and proposed new railway connections on the Swiss and French side of the Simplon tunnel. 2000 w. Revue Technique—March 25, 1905. No. 69140 D.

PERMANENT WAY AND BUILDINGS.

Engine Houses.

New Engine Houses at Elkhart, L. S. & M. S. Ry. Illustrates and describes this example of the latest phase of development of engine houses, which makes running repairs possible, and furnishes a system of piping for blowing off, washing out and filling boilers. 4500 w. Ry & Engng Rev—April 1, 1905. No. 68765.

Improvements.

Pennsylvania Improvements at Wilmington, Del. Illustrates and describes improvements including a brick arched viaduct, drawbridge, and other changes. 1200 w. Ry Age—March 31, 1905. No. 68766.

Rails.

A Railway Rail and Its Relation to the Wheel and Tie. W. F. Gould. Discusses the changes in rails by wear, and the creeping of rails, and the movements the rail has to resist. General discussion. 3500 w. Pro Iowa Ry Club—March 13, 1905. No. 69003 C.

The Best Metal for Rails. P. H. Dudley. Abstract of a report to the Int. Ry. Cong. giving the result of American experience. 1300 w. Ir & Coal Trds Rev—March 24, 1905. No. 68754 A.

Repair Shops.

A Plan for Maintaining Railroad Repair Shop Machinery. M. K. Barnum. On the importance of well-equipped toolrooms. With a very interesting discussion. 17000 w. Pro W Ry Club—March 21, 1905. No. 68999 C.

Round-Houses.

Round-House Framing. R. D. Coombs. Gives the writer's ideas of desirable construction. Ills. 2500 w. Pro Am Soc of Civ Engrs—April, 1905. No. 69266 E.

Signalling.

Automatic Block Signals. Ralph Scott. Illustrates and describes the standard Hall electro-gas signal. 3000 w. Am Elect'n—April, 1905. No. 68813.

Station.

The New Central Station at Sidney, New South Wales. Illustration with description of a new station under construction costing nearly $5,000,000. 2700 w. Eng News—March 30, 1905. No. 68831.

Terminals.

Canadian Pacific Improvements at Victoria. An illustrated article describing the improvement of railroad property at this point, including the building of a fine hotel. 1500 w. R R Gaz—Vol. XXXVIII, No. 16. No. 69076.

Ties.

Experiments with Treated Cross-Ties in Texas. Notes from a report by Dr. Hermann von Schrenk, of the results of extensive tests made on railroad ties. 4500 w. Eng Rec—April 15, 1905. No. 68972.

Yards.

Design and Operation of a Modern Freight Yard. Joseph T. Richards. Considers a plan for a general yard design and the method of operating it. Discussion. 3000 w. Pro Engrs' Club of Phila—April, 1905. No. 69035 D.

Hump Yards at Dewitt, N. Y. C. & H. R. R. R. Gives plan of the yards, showing the great network of tracks and the hump by which the distribution and classification of freight traffic is effected. 600 w. Ry & Engng Rev—April 1, 1905. No. 68764.

TRAFFIC.

Rates.

A Simple Scheme of Rate Regulation. Judge P. S. Grosscup. Extracts from an address before the Union League Club, Chicago. Discusses various phases of the rate question, and gives his opinion in favor of a transportation department of government. 3500 w. Ry Age—April 28, 1905. No. 69279.

Federal Regulation of Railway Rates. Albert N. Merritt. A discussion of this subject, concluding that government regulation, beyond that now exercised, is a dangerous policy. 3300 w. Ry Age—April 7, 1905. No. 68881.

Government Rate Making and the Constitution. George R. Peck. Abstract of an address delivered before the Union League Club, Chicago. Considers that the making of rates by the Interstate Commerce Commission would result, in many cases, in a violation of the constitution. 2200 w. Ry Age—April 21, 1905. No. 69092.

Railway Rate Regulation.—Its Bearing Upon Public Transportation. James L. Cowles. Advocating the extension of the postal system to general transport rates as a solution of the railway-rate problem. 1000 w. Sci Am Sup—April 22, 1905. No. 69088.

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STREET AND ELECTRIC RAILWAYS

Car Designs.

Car Designs and Carrying Capacity. John P. Fox. Discusses the seating arrangements of some 24 different types of cars, with suggestions. Editorial also. 7700 w. St Ry Jour—April 1, 1905. No. 68815 C.

Combination.

The West Penn Railways System. Illustrated description of a system formed by the union of several disconnected lines in western Pennsylvania. 3500 w. St Ry Rev—April 15, 1905. No. 69067 C.

Controllers.

The Burning Out of Electric Street-Car Controllers. Sydney W. Ashe. Gives an account of experimental investigations to study the behavior of an arc during the time that elapses for a fuse to blow, and discusses the remedy. 1500 w. Eng News—April 20, 1905. No. 69080.

Discussion.

Development in Electric Traction. Discussion of paper presented by W. B. Potter at the January meeting. 11800 w. Pro N Y R R Club—March 17, 1905. No. 69002.

Electric Locomotives.

Control of Electric Locomotives. William Cooper. Considers methods of controlling the pull on the coupling. 2000 w. Elec Rev, N Y—April 8, 1905. No. 68883.

Oerlikon Electric Locomotives. C. O. Mailloux. Illustrated description of two types of single-phase a. c. electric locomotives, with information concerning them. 2400 w. St Ry Jour—April 8, 1905. No. 68887 C.

The New Electric Locomotives for the Valtellina Railway (Neue Elektrische Lokomotiven Type R. A. 1903, für die Valtellinabahn). E. Cserhati. A fully illustrated description of the new three-phase locomotives for the Lecco-Colico-Sondrio line in Northern Italy. Two articles. 5000 w. Zeitschr f Elektrotechnik—April 9, 16, 1905. No. 69156 each D.

Evolution.

Synopsis of Paper on the Evolution of the Street Railway. Richard McCulloch. Some interesting statements in regard to the progress and growth. 1300 w. Pro St Louis Ry Club—March 19, 1905. No. 69000.

Funeral Car.

Funeral Car at Buffalo. Brief illustrated description. 300 w. St Ry Jour—April 1, 1905. No. 68816 C.

Interurban.

The Columbus, Newark & Zanesville Electric Railway. Illustrated detailed description of this Ohio line and its equipment. 3500 w. St Ry Jour—April 15, 1905. No. 68944 C.

Manila.

The First Philippine Electric Railway. A brief illustrated article giving information of this recently opened line. 900 w. Sci Am Sup—April 29, 1905. No. 69255.

Opening of the Electric Railway System in Manila, P. I. Illustrated detailed description of the reconstruction and electrification of the street railways, and matters related. 3500 w. St Ry Jour—April 29, 1905. No. 69310 C.

Motive Power.

The Attitude of the Steam Roads. Louis Bell. Discusses some phases of the present situation in railway operation. 2000 w. St Ry Jour—May 6, 1905. No. 69445 C.

Permanent Way.

Tramways Permanent-Way Construction and Maintenance. James Lord. Read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Results of the author's experience of 21 years in the repairing and construction of municipal tramways. 3000 w. Elec Engr, Lond—March 24, 1905. No. 68748 A.

Philippines.

Electric Lighting and Railway Construction in the Philippines. Illustrated description of the reconstruction and extension of the lighting and power system, the electrification of the horse car lines and of a short steam line. 2500 w. Elec Wld & Engr—May 6, 1905. No. 69426.

Power Supply.

Dundee Power Supply. An explanation of a system of charging for electrical energy recently placed before the Tramway Committee of the Dundee Corporation. 1800 w. Elec Engr, Lond—April 7, 1905. No. 68984 A.

Rail Bonding.

Rail Bonding on the Brooklyn Heights Railroad. Howard C. Forbes. Illustrated description of heavy bonding where not only the track but the longitudinal girders of an elevated structure were used to carry the return current. 1600 w. St Ry Rev—April 15, 1905. No. 69070 C.

We supply copies of these articles. See page 477.

Railway Motors.

Is a Universal Type of Railway Motor Advisable? A. H. Armstrong. Discusses the various types of motors and their advantages and concludes that while uniformity is desirable, the best interests of a system are conserved by adapting the motive power to the requirements. 2800 w. St Ry Jour—April 15, 1905. No. 68045 C.

Rolling Road.

A New Rolling Road at Cleveland, Ohio. D. A. Willey. Illustrated description of the application of the electric current in connection with a rolling roadway of pulling loaded vehicles up a high grade. 900 w. Elec Rev, N. Y.—April 8, 1905. No. 68885.

Rolling Stock.

Improvements on the Motor Cars of the Metropolitan West Side Elevated Railway Company, Chicago. An illustrated article describing a number of important improvements, especially in wiring. 5500 w. St Ry Jour—April 22, 1905. No. 69096 C.

Single-Phase.

A New Single-Phase Railway Equipment. A. Frederick Collins. Reviews some of the three-phase alternating current systems of Europe and gives an illustrated description of the single-phase alternating current equipment of the General Electric Company. 1700 w. Sci Am Sup—April 22, 1905. No. 69089.

Single-Phase Line Construction. Theodore Varney. Illustrates and describes features developed with the view of making this high voltage system thoroughly safe and reliable with a minimum cost. 1100 w. Elec Club Jour—April, 1905. No. 69025.

General Electric Single-Phase Railway. Illustrated description of details of the single-phase system between Pontiac and Odell in Illinois. 1000 w. Elec Wld & Engr—May 6, 1905. No. 69428.

The Bloomington, Pontiac & Joliet Single-Phase Electric Railway. John R. Hewett. Illustrated detailed description of the first line of single-phase current above, opened for public service in the United States. 2800 w. St Ry Jour—May 6, 1905. No. 69442 C.

Signals.

Automatic Signal and Safety Systems as Applied to Electric Railways. Edward Taylor. Deals chiefly with the weak points of the signal systems, showing that there is still room for improvement. 3500 w. St Ry Jour—May 6, 1905. No. 69444 C.

Subway Accident.

Another Accident in the New York Subway. An illustrated account of the accident near 168th street on March 29, with editorial. 2000 w. R R Gaz—Vol. XXXVIII, No. 14. No. 68820.

Subways.

Chicago's Underground Freight Traffic. George E. Walsh. Compares conditions in New York and Chicago, and gives information in regard to the tunnels of the Illinois Tunnel Company. 1600 w. Sci Am Sup—April 1, 1905. No. 68847.

The Double Deck Subway System. Illustrates and describes a subway designed some years ago by J. W. Reno, for conditions under Broadway, New York, with discussion of its advantages. 1200 w. Sci Am—April 8, 1905. No. 68852.

Switches.

The Operation of Automatic Electric Track Switches. Sidney Diamant. An illustrated description of types of electric switches on trial in New York City. 3000 w. St Ry Jour—April 1, 1905. No. 68,817 C.

Testing Car.

New Testing Car of Berlin Traction Company. C. L. Durand. Illustrated description of a model testing and inspection car equipped for making all necessary measurements. 1200 w. Elec Rev, N. Y. —April 8, 1905. No. 68886.

Third Rail.

Third Rail Connections. William A. Del Mar. Outlines a few general principles the neglect of which has proved detrimental to several systems. 1200 w. Elec Wld & Engr—April 22, 1905. No. 69211.

Train Control.

The Electro-Pneumatic System of Train Control. P. C. McNulty. Jr. Illustrated description of this system which has been developed by the Electric Company. 4000 w. Elec Club Jour—April, 1905. No 69026.

Ventilation.

Car Ventilation. Edward Taylor. Gives information gained while testing an important city electric railway system, describing methods and giving other related information. 3500 w. St Ry Jour—April 15, 1905. No. 68946 C.

West Ham.

The Tramway System of West Ham. Describes the conditions in and around this borough, illustrating and describing the contruction of the electric tramways, the power station, rolling-stock, &c. 5000 w. Tram & Ry Wld—April 6, 1905. No. 69075 B.

We supply copies of these articles. See page 477.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architecaural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-w.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Concrete.

Reinforced Concrete. By A. W. Buel and C. S. Hill. Size, 9 in. by 6 in.; pp. x, 434. Price, $5.00. New York: Engineering News Publishing Company.

With the increasing interest and numerous applications of reinforced concrete as a method of construction there has arisen a demand for reliable text books for the use of the engineer and student upon this new system of construction. The present volume consists of two independent parts, the first portion, from the pen of a well-known civil engineer, treating of the scientific principles involved in the proportioning of reinforced-concrete structures, and the second part including a large number of executed examples of foundations, bridges, conduits, reservoirs, and other structures. There are also chapters discussing the practical methods employed in reinforced-concrete work, the whole forming a complete manual of the subject.

Mr. Buel examines the various theories, as applied to beams, columns, walls, and arches, discussing the methods of Considère and of Thacher, with tables for beams of various depths and spans computed from Thacher's formulas. The computations for retaining walls, dams and similar structures are examined graphically, while the elastic theory for arches, as confirmed by the Austrian tests, is given, together with the approximate methods of Von Emperger.

The manner in which Mr. Buel has treated this whole question of proportions and design renders the book of especial value for the working engineer, the methods given being practical and applicable to a great variety of structures and involving only such a knowledge of mathematics as should be available in any office. In the present state of knowledge as to the properties of reinforced concrete it is useless to attempt any extreme degree of precision in computations, and the methods given by Mr. Buel are entirely within the practical limits of the materials employed.

The second portion of the book, due to Mr. Hill, contains a wealth of illustration in the form of working drawings of executed work, and thus appeals directly to the engineer and builder in similar lines of work.

Electricity.

Alternating Current Machinery. By William Esty, S. B., M. A. Size, 10 in. by 7 in.; pp. 432. Price, $3.75. Chicago: American School of Correspondence.

It is generally considered that the phenomena of alternating current machinery cannot be properly treated without the use of the higher mathematics, and hence most books on the subject are practically unreadable for the practical station man and electrician. Professor Esty has met this objection in the present work, which forms one of the excellent set of books issued by the American School of Correspondence of the Armour Institute of Technology, and he has shown that the subject can be very thoroughly explained to any one possessing a knowledge of no more mathematics than algebra, geometry, and trigonometry. By the use of graphical and geometric methods rather than those of analysis, and by the reduction of abstract and arbitrary statements to a minimum, the study of a subject naturally difficult is rendered as simple as possible.

The work begins with a discussion of the principles of the alternator, followed by descriptions of commercial types of alternators, while succeeding chapters treat of synchronous motors, transformers, rotary converters, induction motors, and the various appliances required for syitchboard, station, and line service. The book is copiously illustrated with diagrams and examples of actual installations, and forms a very complete treatise upon one of the most important departments of applied electricity.

Gas Engines.

Gas Engines and Producer-Gas Plants. By R. E. Mathot. Translated by Waldemar B. Kaempffert. Size, 9 in. by 6 in.; pp. xiv, 314. Price, $2.50. New York: Norman W. Henley Publishing Co.

This is a thoroughly practical book by an author who is both a practical and

scientific man, and as such it is a welcome contribution to an important department of technical literature. Leaving aside elaborate theories and thermodynamic studies, Mr. Mathot gives the purchaser and user of the gas engine the benefit of his extensive practical experience in all the details of selection, installation, and operation of these machines. The subject of gas producers, both pressure and suction, is fully discussed, and the practical difficulties which are encountered in the operation of gas-power plants are indicated, and the remedies suggested. The chapters on pressure gas producers and on suction gas producers are of especial value, and the latter system appears to offer great promise in extending the use of internal-combustion motors for small and medium powers.

The translation is excellently done, with the exception of a curious incompleteness in the conversions of the metric values into their British equivalents, thermal values per cubic metre being converted into B. T. U. per 35.31 cubic feet instead of per cubic foot; and the calorific values of coals into B. T. U. per 2.2 pounds, instead of per pound, the result being the presentation of familiar values in wholly unfamiliar forms. The conversion is readily completed, however, and otherwise the book is altogether satisfactory.

Panama.

Problems of the Panama Canal. By Brig.-Gen. Henry L. Abbot, U. S. A. Size, 8 in. by 5 in.; pp. xii, 248. Price, $1.50. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

General Abbot has done excellent service by gathering in this volume much valuable information concerning the Panama canal, and the problems which must be solved in its successful completion. The unsurpassed opportunities possessed by Gen. Abbot by reason of his official connection with the *Comité Technique* and with the Commission of the New Panama Canal Company give ample assurance of the accuracy of his information, while his high reputation as an engineer and his familiarity with hydraulic problems give his opinions great weight.

After a brief historical introduction and a consideration of the rival routes for an isthmian canal, Gen. Abbot proceeds to discuss the physical conditions on the isthmus, including the topography, geology, and climatology of the region. This is followed by an examination of the great problem of the undertaking, the Chagres river and its regulation. Although the difficulties of the work are great, Gen. Abbot believes that they have been overestimated, and states that the control of the Chagres is, in his opinion, a less formidable task than that of the regulation of the Warrior and Black Warrior rivers, of Alabama, a work proceeding without attracting especial attention.

In examining the various projects for the canal, Gen. Abbot expresses his strong approval of a lock canal with dual lake control of the Chagres, dams being built at Bohio and at Alhajuela, the summit level being 20 metres above sea level. The reasons for this view are fully set forth in the book, and the convincing nature of the arguments will be appreciated by any one who examines the subject in the light of the information contained in the volume. The book is well illustrated by numerous diagrams, and a large folding map of the route of the canal is given, reprinted from the issue of this Magazine for February, 1900.

BOOKS RECEIVED.

Descriptive Geometry for Students of Engineering. By James Ambrose Moyer. New York: John Wiley and Sons. London: Chapman and Hall, Limited.

American Society for Testing Materials. Proceedings of the Seventh Annual Meeting. Philadelphia: Office of the Secretary, University of Pennsylvania.

The Testing of Continuous Current Machines in Laboratories and Test Rooms. By Charles Kinzbrunner. New York: John Wiley and Sons.

The Principal Professional Papers of Dr. J. A. L. Waddell. Edited by John Lyle Harrington. New York: Virgil G. Hewes.

Marine Engines and Boilers. Translated from the German of Dr. G. Bauer by E. M. Donkin and S. Bryan Donkin. Edited by Leslie S. Robertson. London: Crosby Lockwood and Son. New York: The Norman W. Henley Publishing Company.

Steam Pipes, Their Design and Construction. By W. H. Booth. New York: The Norman W. Henley Publishing Company. London: Crosby Lockwood and Son.

A Handbook for Superintendents of Construction, Architects, Builders and Building Inspectors. By H. G. Richey. New York: John Wiley and Sons. London: Chapman and Hall, Limited.

Practical Electric Light Fitting. By F. C. Allsop. New York: The Macmillan Co. London: Whittaker and Co.

American Telephone Practice. By Kempster B. Miller. Fourth Edition. Enlarged and Entirely Rewritten. New York: McGraw Publishing Company.

A Treatise on Concrete, Plain and Reinforced. By Frederick W. Taylor and Sanford E. Thompson. New York: John Wiley and Sons. London: Chapman and Hall, Limited.